CAT QUANTITATIVE APTITUDE

THE COMPLETE ULTIMATE STRATEGY & BLUEPRINT GUIDE

EXAM FRAMEWORK & BREAKDOWN		SYLLABUS DYNAMICS & SCORING	
Exam	CAT (Common Admission Test)	**Section**	Quantitative Aptitude (QA)
Total Questions	22 Questions (Strict 40-Minute Window)	**Scoring Scheme**	+3 for Correct, -1 for MCQ Mistakes, 0 for TITA
Core Blocks	Arithmetic (35-45%), Algebra (30%), Geometry (15-20%), Number Systems & Modern Math (10-15%)		

COMPREHENSIVE NAVIGATION ROADMAP

This master framework covers the entire Quantitative Aptitude section from structural property expansions down to operational scenario scaling. Use this unified companion guide for daily revision sessions and post-mock analytical breakdowns.

- **Section 1 & 2:** General Strategy Matrix + Deep-Dive Arithmetic Chapter-wise Coverage.
- **Section 3 & 4:** Advanced Algebra Mechanisms + Core Geometry & Mensuration Blueprints.
- **Section 5 & 6:** Number Systems, Progressions & Modern Math Core Formulations.
- **Section 7 & 8:** The Universal CAT QA Trap Master List + Speed Math Engine & Mathematical Foundations.

Unified Preparation Suite for Comprehensive Quant Percentile Scaling

Cross-Sectional Concept Summaries • Comprehensive Trap Matrices • Vedic Speed Mechanics • Comprehensive Appendices

Target Target Milestone: 99.99 Percentile in QA

1. COMPREHENSIVE STRATEGY & SECTIONAL WEIGHTAGE

The Quantitative Aptitude (QA) section in the Common Admission Test (CAT) requires a strategic balance of speed, selectiveness, and accuracy. Comprising exactly 22 questions to be answered in a timed 40-minute window, this section tests your structural competence under processing pressure rather than extensive calculation stamina. The layout follows predictable cluster blocks where Arithmetic and Algebra maintain a majority share, combined with high-impact blocks across Geometry, Number Systems, and Modern Math.

Sectional Distribution Matrix

CORE CURRICULAR BLOCK	TYPICAL QUESTION COUNT	APPROXIMATE SHARE	STRATEGIC PRIORITY FOCUS AREAS
Arithmetic	8 - 10 Questions	36% - 45%	TSD, Time & Work, Profit & Loss, Weighted Averages, Dilution Mixtures
Algebra	5 - 7 Questions	23% - 32%	Quadratic Equations, Polynomial Theorems, Nested Modulus, Logarithms
Geometry & Mensuration	3 - 4 Questions	14% - 18%	Triangle Congruency, Circle Inscriptions, Coordinate Geometry lines, Solids
Number Systems & Modern Math	2 - 3 Questions	9% - 14%	Remainder Cyclicity, Base Changes, Permutations, Probability, Sets

To cross the 99th percentile benchmark (~30-35 absolute marks depending on yearly slot variances), an aspirant does not need to crack all 22 questions. The sweet spot relies on a net positive score extracted from 11-13 highly accurate attempts. TITA (Type In The Answer) inputs constitute roughly 20% to 30% of the section, carrying zero negative mark penalty, and must be optimized as safe point zones without running formula-fitting gambles.

2. CHAPTER-WISE CORE TOPIC COVERAGE: ARITHMETIC ENGINE

Chapter 2.1: Percentages & Successive Ratios

Percentages establish the operational framework for transaction evaluation and comparative analysis across all arithmetic layouts.

- **Base Change Mechanics:** If value A is $x\%$ more than B, then B is lower than A by exactly $\left(rac{x}{100+x} ight) imes 100\%$. Utilizing clean fractions, a positive scale change of $rac{a}{b}$ requires a corresponding negative shift of $rac{a}{a+b}$ to restore structural equivalence.
- **Successive Multipliers:** Compounded sequential shifts bypass intermediate values entirely using direct multipliers:

$$Net\ \% = a + b + rac{ab}{100}$$

- **Reverse Percentages:** Crucial for working directly backward from post-increment states. If an item is valued at V_f after a 25% appreciation, its baseline point is $V_i = rac{V_f}{1.25}$, never $V_f imes 0.75$.

Chapter 2.2: Profit, Loss & Cheating Traders

Trading mechanics optimize basic profit and margin ratios across sequential supply chain transformations.

- **The Markup Margin Equivalence:** Markup is anchored strictly to the baseline Cost Price (CP), while margin scales on the final Selling Price (SP). The foundational transformation chain is:

$$SP = CP imes \left(1 + rac{Profit\%}{100} ight) = MP imes \left(1 - rac{Discount\%}{100} ight)$$

- **Faulty Weights Optimization:** When a merchant claims cost-price trading but scales down the quantity using a faulty scale delivering G grams instead of the benchmark T grams, the net profit percentage is determined strictly relative to the delivered baseline:

$$Profit\% = \left(\frac{True\ Weight\ (T) - Faulty\ Weight\ (G)}{Faulty\ Weight\ (G)} \right) \times 100$$

Chapter 2.3: Time, Speed & Distance (Proportionality & Kinematics)

TSD parameters scale via inverse and direct proportionality constants, structuring multi-object motion paths.

- **Constant Constraints:**
  - If Distance is constant: Speed scales inversely with Time ($S_1/S_2 = T_2/T_1$).
  - If Time is constant: Distance tracks directly with Speed ($D_1/D_2 = S_1/S_2$).
- **Relative Speed Frameworks:** Parallel objects moving in identical vector paths subtract individual velocities ($S_{eff} = |S_1 - S_2|$). Objects meeting from opposing horizons add their speeds ($S_{eff} = S_1 + S_2$).
  Circular Tracks: Two runners meet for the first time anywhere on a closed loop in time $T = \frac{Length}{S_{eff}}$, and at the starting mark at $LCM(T_1, T_2)$.
- **Boats & Streams:** Downstream vector is $D_s = u + v$, upstream vector is $U_s = u - v$ (where u represents object speed in still environments and v is the stream current velocity).

Chapter 2.4: Time & Work / Pipes & Cisterns

Capacity processing problems resolve rapidly by converting raw temporal timelines into standalone efficiency modules.

- **The LCM Capacity Technique:** Do not add slow fraction units like $\frac{1}{A} + \frac{1}{B}$. Establish the total workload as the LCM of individual completion periods, determining exact unit outputs per day. If A takes 12 days and B takes 15 days, total work becomes 60 units. Hence, $A = 5$ units/day, $B = 4$ units/day. Combined capacity = 9 units/day; total timeline = $60/9 = 6.66$ days.
- **Negative Efficiency:** Cistern leakage parameters subtract directly from the net hourly filling input rate.

3. CHAPTER-WISE CORE TOPIC COVERAGE: ALGEBRA FOUNDATIONS

Chapter 3.1: Quadratics, Polynomials & Conjugacy

Polynomial fields evaluate structural symmetry, root tracking rules, and boundary configurations.

- **The Discriminant Filter:** For any standard quadratic expression $ax^2 + bx + c = 0$, the root behavior tracks the value of $\Delta = b^2 - 4ac$. If $\Delta > 0$ and forms a perfect square, roots are real, rational, and distinct. If $\Delta = 0$, roots merge symmetrically at $x = -b/2a$. If $\Delta < 0$, roots are complex conjugates.
- **Vieta's Higher order Relations:**
  - Quadratic: Sum ($\alpha + \beta = -b/a$) | Product ($\alpha\beta = c/a$).
  - Cubic ($ax^3+bx^2+cx+d=0$): Sum ($\sum \alpha = -b/a$) | Pairwise Sum ($\sum \alpha\beta = c/a$) | Product ($\alpha\beta\gamma = -d/a$).
- **Irrational Root Conjugacy:** For polynomials with rational coefficients, surd and complex solutions occur in identical conjugate blocks. If one root is $3 + \sqrt{5}$, its partner is automatically $3 - \sqrt{5}$.

Chapter 3.2: Inequalities, Functions & Logarithmic Bounds

Domain verification sets precise input boundaries, validating variables against function constraints.

- **Nested Modulus Expansion:** Geometrically, $|x - a| \le b$ identifies a continuous boundary range centered at a stretching a distance of b in both directions: $a - b \le x \le a + b$. For nested chains, find the exact zero-intercepts for each modulus block to partition values across discrete evaluation zones.
- **Logarithmic Boundaries:** For any legal expression $\log_B A$, the parameter domain constraints must satisfy:

$$Argument\ A > 0 \quad;\quad Base\ B > 0 \quad;\quad Base\ B \neq 1$$

- **Inequality Base Shift:** When dropping logs across an inequality chain ($\log_a x > \log_a y$), the sign holds direction if base $a > 1$. If the base sits as a fraction $0 < a < 1$, the function decays, and the inequality direction flips completely ($x < y$).

4. CHAPTER-WISE CORE TOPIC COVERAGE: GEOMETRY BLUEPRINT

Chapter 4.1: Triangles, Circles & Inscribed Polygons

Geometric proofs rely heavily on properties of scale, line intersections, and area optimization.

- **The Apollonius Theorem:** In any triangle with sides a, b, c and a median m_a dropped onto side a splitting it into halves, the side relation scales as:

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

- **Inradius vs. Circumradius:** For all general triangles, the inradius is $r = \frac{Area\ (\Delta)}{Semiperimeter\ (s)}$, and the circumradius tracks as $R = \frac{abc}{4 \cdot Area\ (\Delta)}$. In right-angled systems, the circumradius simplifies to half the hypotenuse ($R = H/2$), and the inradius drops to $r = \frac{P + B - H}{2}$.
- **Circle Chord Intersections:** If two internal chords cross paths at point P within a circle, their segment products match perfectly: $AP \cdot PB = CP \cdot PD$. If a external secant cuts through a circle at segment line points $P\text{-}A\text{-}B$ and meets a tangent at point T, then $PT^2 = PA \cdot PB$.

Chapter 4.2: Mensuration & Coordinate Line Equations

Mensuration tracks cross-sectional expansions, while coordinate planes analyze algebraic trajectories.

- **Cross-Sectional Scalings:** If all spatial dimensions of a 3D solid increase uniformly by a factor of k, its outer surface boundary area scales by k^2, and its internal volumetric mass scales exponentially by k^3.
- **Coordinate Intersections:** Two straight lines $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$ cross perpendicularly if their slope products equal -1 ($m_1 \cdot m_2 = -1$). They are perfectly parallel if slopes match ($m_1 = m_2 \implies \frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$), yielding no solution sets.

5. NUMBER SYSTEMS, PROGRESSIONS & MODERN MATH MATRIX

Chapter 5.1: Remainders, Cyclicity & Divisibility Rules

Modular math isolates scale properties, converting multi-digit transformations into compact cyclic patterns.

- **Euler's Totient Theorem:** If numbers a and n are coprime, then the remainder of $\frac{a^{\phi(n)}}{n}$ is exactly 1, where $\phi(n) = n \prod (1 - 1/p_i)$ represents the count of numbers less than n coprime to it.
- **Highest Power Factorial Rules (Legendre's Formula):** To isolate the maximum exponent of a prime number p that divides a factorial value $N!$ completely, sum the integer quotients across repeating powers:

$$E_p(N!) = \lfloor \frac{N}{p} \rfloor + \lfloor \frac{N}{p^2} \rfloor + \lfloor \frac{N}{p^3} \rfloor + \dots$$

- **Divisibility Constraints:** A number tracks divisibility by 11 if the absolute difference between the sum of digits in odd positions and even positions resolves to 0 or a clean multiple of 11. Divisibility by 8 requires only the trailing three digits to form a multiple of 8.

Chapter 5.2: Progressions, Permutations & Probability Sets

Progressions trace structural growth patterns, while Modern Math formulas calculate combination counts.

- **The AM-GM-HM Inequality Chain:** For any sequence of positive real terms, their calculated means maintain an absolute scale boundary:

$$\frac{a+b}{2} \ge \sqrt{ab} \ge \frac{2}{\frac{1}{a} + \frac{1}{b}}$$

Symmetric equity ($AM = GM = HM$) holds true if and only if all evaluated individual variables match perfectly ($a = b$). Use this sequence constraint whenever maximizing product variables or finding the floor of an absolute summation.

- **Geometric Series Limits:** An infinite descending geometric progression resolves to a single finite limit if the absolute common ratio satisfies $|r| < 1$, calculated via: S_\infty = rac{a}{1-r}.
- **Circular Permutations:** Arrangement count for n unique elements along a closed loop is $(n-1)!$. If the physical orientation lacks top/bottom distinction (e.g., a bead necklace), the unique count drops to rac{(n-1)!}{2}.
- **De Morgan's Set Unions:** Total unique elements covered across three intersecting sets tracks via:

$$n(A \cup B \cup C) = \sum n(A) - \sum n(A \cap B) + n(A \cap B \cap C)$$

6. STRUCTURAL FORMULA COMPENDIUM

Core Equations: Quantitative Functions

- Power Change Shortcut

CURRICULAR TARGET CONCEPT	PRIMARY MATHEMATICAL FORMULATION	OPERATIONAL DIRECT FORM SHORTCUT
Successive Net %	Net\% = a + b + rac{ab}{100}	Compounded Multipliers: MF_{net} = M_1 imes M_2
Weighted Balance	A_{avg} = rac{n_1A_1 + n_2A_2 + \dots + n_kA_k}{n_1 + n_2 + \dots + n_k}	Alligation Cross: $n_1(A_{avg} - A_1) = n_2(A_2 - A_{avg})$
Repeated Dilution	C_{final} = C_{initial}\left(1 - rac{x}{V} ight)^n	Tracks original concentration decay scaling
Kinematic Speed Mean	S_{avg} = rac{2S_1S_2}{S_1 + S_2}	Harmonic mean applied strictly across equal distances
Cubic Vieta Sum	ax^3 + bx^2 + cx + d = 0 \implies \sum lpha	Symmetric root scale value: $-b/a$
Cubic Pairwise Sum	ax^3 + bx^2 + cx + d = 0 \implies \sum lpha eta	Pairwise product scale match: c/a
Log Base Change Rule	\log_a b = rac{\log_c b}{\log_c a}	Convert multi-base loops to standard natural logs
$a^{\log_c b} = b^{\log_c a}$	Swaps exponential bases across outer parameters	

Core Equations: Spatial & Counting Systems

CURRICULAR TARGET CONCEPT	PRIMARY MATHEMATICAL FORMULATION	OPERATIONAL DIRECT FORM SHORTCUT
Inradius Bounds	r = rac{Area\ (\Delta)}{Semiperimeter\ (s)}	Right-Angled shortcut: r = rac{P + B - H}{2}
Circumradius Geometry	R = rac{abc}{4 \cdot Area\ (\Delta)}	Right-Angled hypotenuse midpoint: $R = H/2$
Apollonius Median	$b^2 + c^2 = 2(m_a^2 + (a/2)^2)$	Isolates spatial lengths without coordinate mappings
Legendre Factor Power	E_p(N!) = \sum_{k=1}^{\infty} \lfloor rac{N}{p^k} floor	Tracks exact prime factors in factorials

CURRICULAR TARGET CONCEPT	PRIMARY MATHEMATICAL FORMULATION	OPERATIONAL DIRECT FORM SHORTCUT
Infinite Series Sum	$S_\infty =$ rac{a}{1-r}	Requires absolute convergence condition: $\|r\| < 1$
Derangements Count	$D_n = n! \sum_{k=0}^{n}$ rac{(-1)^k}{k!}	Direct terms shortcut: $D_n = (n-1)(D_{n-1} + D_{n-2})$

7. COMPREHENSIVE CAT QA TRAP MASTER LIST

Trap 1: The Linear SI Multi-Year Base Compounding Mirage

Flawed Approach: Compounding interest balances during multi-stage problems involving Simple Interest calculations.
Correct Approach: Simple Interest adds fixed absolute amounts based exclusively on the initial baseline principal.
CAT Case Example: If an asset triples in 6 years under SI, it adds 200% principal. To reach 7 times the principal (600% growth), it takes exactly 18 years, not 12 years.

Trap 2: Average Speed Arithmetic Illusion across Fixed Routes

Flawed Approach: Averaging travel speeds for a round trip via simple arithmetic means: rac{S_1 + S_2}{2}.
Correct Approach: Since the destination route distance matches perfectly, speed tracks inversely to time, requiring the harmonic mean: rac{2S_1S_2}{S_1 + S_2}.
CAT Case Example: Commuting at 30 km/h and returning along the same stretch at 60 km/h yields a net speed of 40 km/h, not 45 km/h.

Trap 3: Circular Track Meeting Points vs. Starting Line Clashes

Flawed Approach: Conflating the initial encounter point anywhere along a loop with the first simultaneous meeting at the starting block.
Correct Approach: Objects meet anywhere in time $T =$ rac{Length}{S_{eff}}. They align at the starting mark at $LCM(T_1, T_2)$.
CAT Case Example: Quick runners pass each other multiple times on a loop before aligning back at the starting line simultaneously.

Trap 4: Missing the Base = 1 Boundary Disconnect in Logarithms

Flawed Approach: Accepting variable solutions from log quadratics that inadvertently force base parameters to equal 1.
Correct Approach: The base must be positive and strictly avoid 1. Throw out any solutions that violate this constraint.
CAT Case Example: Solving $\log_{(x-3)} 25 = 2$ yields $x=8$ and $x=2$. Since $x=2$ leaves a negative base, it is rejected. If a root makes the base exactly 1, discard it immediately.

Trap 5: Blind Inequality Variable Cross Multiplication

Flawed Approach: Cross-multiplying variables across an inequality sign without knowing their underlying numerical sign.
Correct Approach: Never cross-multiply variable terms unless their positive/negative sign is structurally proven. Move all elements to one side instead.
CAT Case Example: In rac{x-2}{x-4} > 1, cross-multiplying directly ignores that the expression $(x-4)$ can be negative, flipping the inequality sign.

Trap 6: The Invalid Modulus Solution Range Failure

Flawed Approach: Splitting modulus structures into arbitrary single-sided cases while ignoring core interval parameters.

Correct Approach: Set up precise boundary intervals at each zero-intercept point, verifying that all output roots fall cleanly inside those zones.

CAT Case Example: Solving $|x - 3| = 2x$ requires checking both intervals. The solution $x = -3$ satisfies the negative expansion but fails because a modulus output cannot be negative ($2x \ge 0 \implies x \ge 0$).

Trap 7: Miscounting Overlapping Sets without Null Exclusions

Flawed Approach: Adding intersecting venn circles linearly without accounting for items outside the main categories.

Correct Approach: Always include the external "None" parameter block inside your master universe balance equation.

CAT Case Example: In a class of 100, if 60 pass Test A and 50 pass Test B, assuming the intersection matches overlapping parameters fails if some students failed both tests.

Trap 8: Faulty Scale Base Shift Miscalculation

Flawed Approach: Determining trading margins relative to the target benchmark scale instead of the actual quantity delivered.

Correct Approach: The actual merchant expense corresponds strictly to the weight delivered. Calculate profits using the faulty weight as the base.

CAT Case Example: Substituting 900g for a 1kg target creates a profit margin of $\frac{100}{900} = 11.11\%$, not 10%.

Trap 9: The Infinite Series Convergence Oversight

Flawed Approach: Applying the infinite sum formula $S_\infty = \frac{a}{1-r}$ to progressions without validating the common ratio range.

Correct Approach: This infinite limit holds true if and only if the absolute common ratio tracks strictly within $|r| < 1$.

CAT Case Example: Attempting to calculate the sum of an expanding series where $r = 1.5$ yields an infinite value, making the formula completely invalid.

Trap 10: Polynomial Irrational Roots Conjugacy Failure

Flawed Approach: Factoring complex high-degree equations while treating surd solutions as isolated roots.

Correct Approach: For rational coefficients, surd roots must appear in conjugate pairs. If $2 + \sqrt{3}$ is a root, then $2 - \sqrt{3}$ is its partner.

CAT Case Example: A cubic equation with rational coefficients and a root of $1 + \sqrt{2}$ must contain a hidden factor matching $1 - \sqrt{2}$, pinning down the third root via Vieta's formulas.

8. SPEED TECHNIQUES & QUANTITATIVE FOUNDATIONS SUITE

Vedic Math Shortcuts & Ratio Equivalence Columns

Rapid execution relies on clean mental shortcuts that minimize manual calculation steps during exam pressure.

- **Base Multiplication Engine (Near 100 Baseline):** To multiply numbers hovering near 100, such as 104×108:
  - Identify individual deviations from 100: $+4$ and $+8$.
  - Add one deviation across to the opposite partner number: $104 + 8 = 112$. Scale by 100 $\rightarrow 11200$.
  - Multiply the deviations together: $4 \times 8 = 32$.
  - Combine the calculations: $11200 + 32 = 11232$.

- **The Ratio-Fraction Bridge:** Never process standard percentages via long division. Convert them instantly to fractions:
  12.5\% = rac{1}{8} \quad;\quad 14.28\% = rac{1}{7} \quad;\quad 16.66\% = rac{1}{6} \quad;\quad 11.11\% = rac{1}{9} \quad;\quad 9.09\% = rac{1}{11} \quad;\quad 8.33\% = rac{1}{12}

Appendix: Foundations Table

INTEGER (N)	SQUARE VALUE (N^2)	CUBE VALUE (N^3)	POWER OF 2 (2^N)	POWER OF 3 (3^N)	POWER OF 5 (5^N)
1	1	1	2	3	5
2	4	8	4	9	25
3	9	27	8	27	125
4	16	64	16	81	625
5	25	125	32	243	3125
6	36	216	64	729	15625
7	49	343	128	2187	-
8	64	512	256	6561	-
9	81	729	512	-	-
10	100	1000	1024	-	-
11	121	1331	2048	-	-
12	144	1728	4096	-	-
13	169	2197	8192	-	-
14	196	2744	16384	-	-
15	225	3375	32768	-	-
16	256	4096	65536	-	-
17	289	4913	-	-	-
18	324	5832	-	-	-
19	361	6859	-	-	-
20	400	8000	-	-	-
25	625	15625	-	-	-
30	900	27000	-	-	-

9. SECTIONAL QUICK REVISION CARDS

REVISION SUITE 1: ARITHMETIC STRATEGY

Core Equations: $Net\% = a + b + rac{ab}{100}$ | $S_{avg} = rac{2S_1S_2}{S_1 + S_2}$

Proportionality Laws: Constant Distance implies Speed scales inversely with Time ($S \propto 1/T$). Total Work tracks as Efficiency multiplied by Time.

High-Probability Pitfall: Do not use absolute margins on target metrics for cheating trader layouts; always compute gains using the delivered faulty weight as your base.

REVISION SUITE 2: ALGEBRA & FUNCTIONS

Core Equations: $x = rac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ | $lpha + eta = -b/a$ | $lpha eta = c/a$

Domain Constraints: For any expression $\log_B A$, check that $A > 0, B > 0, B eq 1$ before expanding. Flip inequalities if the log base is a fraction.

High-Probability Pitfall: Avoid cross-multiplying unproven variables across inequalities; move all elements to one side to keep your signs clear.

REVISION SUITE 3: GEOMETRY & SPATIAL PROOFS

Core Equations: $r = Area/s$ | $R = rac{abc}{4 \cdot Area}$ | $b^2 + c^2 = 2(m_a^2 + (a/2)^2)$

Geometric Rules: In right-angled configurations, the circumradius lies at the midpoint of the hypotenuse ($R = H/2$), and the inradius drops to $r = rac{P + B - H}{2}$.

High-Probability Pitfall: When scaling 3D objects uniformly by a factor of k, remember that total area expands by k^2 while volume scales by k^3.

REVISION SUITE 4: NUMBER SYSTEMS & COUNTING SYSTEMS

Core Equations: $a^{\phi(n)} \equiv 1 \pmod n$ | $E_p(N!) = \sum \lfloor rac{N}{p^k} floor$ | $S_\infty = rac{a}{1-r}$

Counting Principles: Circular permutations count tracks at $(n-1)!$. For symmetrical items like necklaces, the unique arrangements drop to $rac{(n-1)!}{2}$.

High-Probability Pitfall: Always verify that the absolute common ratio tracks strictly within $|r| < 1$ before running infinite summation formulas.