

THE CAT ARITHMETIC BLUEPRINT

THE ULTIMATE GROUND-UP MASTER GUIDE & TRAP LIST

EXAM & COURSE OVERVIEW		WEIGHTAGE & USAGE	
Exam	CAT (Common Admission Test)	Section	Quantitative Aptitude
Topic Weightage	8-10 direct questions per paper (~36%-45% of the QA section); highest ROI segment yielding up to 30 marks.		
Guide Length	8 Core Chapters + Compendiums	Best Used As	Reference during study + quick revision suites

1. INTRODUCTION & STRATEGIC ROADMAP

Arithmetic forms the absolute backbone of the Quantitative Aptitude (QA) section in the Common Admission Test (CAT). Historically, across both 2-hour and 3-hour formats, Arithmetic consistently commands the highest share of questions compared to Algebra, Geometry, Number System, and Modern Math. For any serious CAT aspirant, mastering Arithmetic is non-negotiable; it is the highest ROI (Return on Investment) segment where conceptual clarity yields direct, flawless marks.

How to Navigate This Guide:

- **Chapter 2.1 - 2.4:** Anchor core skills in Percentages, Ratios, Averages, and Commercial Interests.
- **Chapter 2.5 - 2.8:** Master core kinematics and work flows in Profit & Loss, Time & Work, TSD, and Solutions.
- **Section 3 & 4:** Memorize the Formula Compendium and flag the Top 20 high-probability pitfalls from the Trap Master List.
- **Section 5, 6 & 7:** Practice Vedic calculation shortcuts, scan the Quick Revision Cards, and use the Appendix metrics to eliminate visual scratchpad reliance.

Comprehensive Preparation Suite for CAT Quantitative Aptitude

8 Chapters • 20 Core Traps • Speed Math Techniques • Formula Compendium • Revision Cards

Target: 99.99 Percentile in QA

1. Introduction: Arithmetic in the CAT Context

Arithmetic forms the absolute backbone of the Quantitative Aptitude (QA) section in the Common Admission Test (CAT). Historically, across both 2-hour and 3-hour formats, Arithmetic consistently commands the highest share of questions compared to Algebra, Geometry, Number System, and Modern Math. For any serious CAT aspirant, mastering Arithmetic is non-negotiable; it is the highest ROI (Return on Investment) segment where conceptual clarity yields direct, flawless marks.

Historical Weightage & Question Patterns

In a standard 22-question CAT Quantitative Aptitude section, Arithmetic typically accounts for 8 to 10 questions. This translates to roughly 36% to 45% of the entire QA section. With each correct answer fetching +3 marks and a negative mark of -1 for Multiple Choice Questions (MCQs), Arithmetic alone controls 24 to 30 marks out of 66. It serves as the primary engine to cross the 95th percentile cut-off for the premier Indian Institutes of Management (IIMs).

CAT YEAR	TOTAL QA QUESTIONS	ARITHMETIC QUESTIONS	APPROXIMATE WEIGHTAGE	KEY AREAS TESTED
CAT 2021 (All Slots)	22	9-10	43%	TSD, Work, Percentages, Mixtures
CAT 2022 (All Slots)	22	8-9	38%	Averages, SI-CI, Profit & Loss
CAT 2023 (All Slots)	22	9	41%	Alligations, Time-Speed-Distance, Ratios
CAT 2024 / 2025 (Avg)	22	8-10	40%	Linear/Circular Races, Partnership, TSD

The questions range from straightforward applications of core concepts to highly wordy, contextual problems designed to simulate corporate business scenarios (e.g., pricing strategies, multi-stage supply chains, optimization of workforce efficiencies). TITA (Type In The Answer) questions constitute around 20-30% of this section, where options are absent, making mechanical formula-fitting dangerous and conceptual clarity paramount.

2. Chapter-Wise Topic Coverage

Chapter 2.1: Percentages

Percentages form the structural currency of Arithmetic. CAT tests your structural comfort with multiplier effects and successive transformations rather than simple computation.

- **Base Change Concept:** If a quantity increases by $x\%$, to restore it to its original value, it must be decreased by $(x/(100+x)) \text{ times } 100\%$. Alternatively, using fractions, an increase of a/b requires a decrease of $a/(a+b)$ to neutralize.
- **Successive Percentage Changes:** Multiple sequential changes are handled via effective multipliers. The net percentage change for two successive increases of $a\%$ and $b\%$ is given by: $\text{Net}\% = a + b + \frac{ab}{100}$
- **Reverse Percentages:** Crucial for working backward from a final value to an initial state. If a value after a 20% increase is V_f , the initial value is $V_i = V_f/1.2$ not $V_f \text{ times } 0.8$.

Chapter 2.2: Ratio & Proportion

Ratios provide a scale-free comparison between quantities, acting as a shortcut to bypass absolute variable values.

- **Direct & Inverse Variations:** If $A \propto B$, then $A_1/B_1 = A_2/B_2$. If $A \propto 1/B$, then $A_1 B_1 = A_2 B_2$. This forms the analytical framework for both Time-Speed-Distance and Time & Work.
- **Compound Ratio & Splitting:** Compounding ratios $a:b$ and $c:d$ yields $ac:bd$. In partnerships, profit split ratios are determined by compounding the capital investment ratio with the time duration ratio: $P_1:P_2 = (C_1 \text{ times } T_1) : (C_2 \text{ times } T_2)$.

Chapter 2.3: Average & Weighted Average

Averages represent the central tendency of a dataset, heavily extended into balance equations by CAT.

- **Assumed Mean (Deviations):** Instead of calculating $\sum X_i/n$, pick an arbitrary central value A. Compute deviations $d_i = X_i - A$. True Mean = $A + (\sum d_i/n)$. This drastically cuts computation during data-heavy inputs.
- **Weighted Average:** When two or more groups with sizes n_1, n_2 and individual averages A_1, A_2 combine:

$$A_{\{avg\}} = \frac{n_1 A_1 + n_2 A_2}{n_1 + n_2}$$
- **Replacement Problems:** If a member of weight $W_{\{old\}}$ is replaced by a member of weight $W_{\{new\}}$ in a group of n elements, changing the average by ΔA , then: $W_{\{new\}} = W_{\{old\}} + n \times \Delta A$.

Chapter 2.4: Simple & Compound Interest

CAT routinely introduces multi-year compounding constraints, continuous shifts, and installment calculations.

- **SI vs. CI Structural Divergence:** Simple Interest grows linearly ($SI = P \cdot r \cdot t / 100$), adding fixed absolute increments based entirely on the initial principal. Compound Interest grows exponentially ($A = P(1 + r/100)^t$), adding interest on accumulated interest.
- **Doubling Time Rule:** For Simple Interest, doubling time is $T = 100/r$. For Compound Interest, a precise approximation is given by the Rule of 72 ($T \approx 72/r$) or the highly accurate Rule of 69.3 ($T \approx 0.3 + 69.3/r$).
- **Difference Formulas:** For 2 years: $CI_2 - SI_2 = P(r/100)^2$. For 3 years: $CI_3 - SI_3 = P(r/100)^2 \times (3 + r/100)$.

Chapter 2.5: Profit, Loss & Discount

This chapter frames optimization math around trading mechanics, evaluating transactions via raw multipliers.

- **Markup, Margin & Selling Equations:** Markup is calculated on Cost Price (CP), whereas Margin is calculated on Selling Price (SP). $Markup\% = ((MP - CP)/CP) \times 100$. The foundational relationship is: $SP = CP \times (1 + \frac{Profit\%}{100}) = MP \times (1 - \frac{Discount\%}{100})$
- **Faulty Weights & Cheating Traders:** If a merchant claims to sell at cost price but uses a faulty weight delivering G grams instead of the true value T grams, the net effective profit percentage is: $Profit\% = \frac{T - G}{G} \times 100$
- **Chain Selling:** Multi-tier transactions are simplified using compounded chain multipliers: $Price_{\{final\}} = Price_{\{initial\}} \times (M_1 \times M_2 \times M_3)$.

Chapter 2.6: Time & Work

Time and Work concepts rely entirely on modeling capacity constraints and processing speeds.

- **The LCM / Efficiency Method:** Avoid adding fraction units ($1/A + 1/B$). Assume Total Work to be the LCM of individual times. Calculate daily unit efficiencies. If Person A takes 10 days and Person B takes 15 days, assume Total Work = 30 units. Efficiency of A = 3 units/day, Efficiency of B = 2 units/day. Combined efficiency = 5 units/day; Time taken = $30/5 = 6$ days.
- **Pipes & Cisterns:** Identical to work mechanics, except inlet pipes represent positive efficiency and outlet/leak pipes represent negative efficiency. If a tank fills in X hours and empties via a leak in Y hours (where $Y > X$), the effective fill rate per hour is $1/X - 1/Y$.

Chapter 2.7: Time, Speed & Distance (TSD)

TSD questions carry massive weightage in CAT, frequently testing relative movement and complex proportionality.

- **Proportionality Frameworks:**
 - If Distance (D) is constant, Speed is inversely proportional to Time ($S \propto 1/T \implies S_1/S_2 = T_2/T_1$).
 - If Time (T) is constant, Distance is directly proportional to Speed ($D \propto S \implies D_1/D_2 = S_1/S_2$).
- **Relative Speed:** Objects moving in the same direction subtract speeds ($S_{\{rel\}} = |S_1 - S_2|$). Objects moving in opposite directions add speeds ($S_{\{rel\}} = S_1 + S_2$). Trains crossing: Time to cross each other = $(Length_1 + Length_2)/S_{\{rel\}}$.
- **Boats & Streams:** Downstream speed ($D_s = u + v$), Upstream speed ($U_s = u - v$), where u is the speed of the boat in still water and v is the speed of the stream.

Chapter 2.8: Mixtures & Alligations

This chapter provides a powerful system for tracking balances when mixing distinct solutions.

- **The Alligation Cross Method:** A mathematical shortcut to find the ratio in which two ingredients must be mixed to achieve a desired average value. $\frac{\text{Quantity of Cheaper } (Q_c)}{\text{Quantity of Dearer } (Q_d)} = \frac{\text{Dearer Price } (d) - \text{Mean Price } (m)}{\text{Mean Price } (m) - \text{Cheaper Price } (c)}$
- **Successive Dilution / Replacement Formula:** If a vessel initially contains V units of pure liquid, and x units are drawn out and replaced with water repeatedly for n operations: $\text{Quantity of Pure Liquid Left} = V(1 - \frac{x}{V})^n$

Chapter 2.9: Number System Basics in Arithmetic

Arithmetic proficiency requires deep comfort with basic integers, patterns, and foundational number theory.

- **Core Divisibility Rules:** Speed depends on instantly scanning numbers. Divisibility by 3 and 9 requires the sum of digits to be divisible by 3 or 9. Divisibility by 4 requires the last two digits to be divisible by 4. Divisibility by 8 requires the last three digits to be divisible by 8. Divisibility by 11 requires the absolute difference between the sum of digits at odd places and even places to be 0 or a multiple of 11.
- **LCM/HCF Properties:** For any two numbers A and B, $LCM(A, B) \times HCF(A, B) = A \times B$. For fractions: $LCM \text{ of Fractions} = \frac{LCM \text{ of Numerators}}{HCF \text{ of Denominators}}$; $HCF \text{ of Fractions} = \frac{HCF \text{ of Numerators}}{LCM \text{ of Denominators}}$
- **Remainder Basics:** Cyclicity properties govern tracking remainders. CAT heavily relies on polynomial remainders where expressions like $(a+1)^n/a$ leave a remainder of 1.

3. Formula Compendium

Percentages & Ratios

CONCEPT / TARGET	PRIMARY MATHEMATICAL FORMULA	OPERATIONAL DIRECT FORM
Successive Net %	$Net\% = a + b + \frac{ab}{100}$	Multiply fractional scale factors: $MF_{\text{net}} = M_1 \times M_2$
Base Restoration	$Decrease = \frac{x}{100+x} \times 100$	An increase of $\frac{a}{b}$ requires a decrease of $\frac{a}{a+b}$
Partnership Profits	$P_1:P_2 = C_1T_1:C_2T_2$	Compounded capital-time product coordinates

Averages, Mixtures & Interlocking Rates

CONCEPT / TARGET	PRIMARY MATHEMATICAL FORMULA	OPERATIONAL DIRECT FORM
Weighted Average	$A_{\text{avg}} = \frac{n_1A_1 + n_2A_2 + \dots + n_kA_k}{n_1 + n_2 + \dots + n_k}$	$n_1(A_{\text{avg}} - A_1) = n_2(A_2 - A_{\text{avg}})$ (Alligation balance)
Alligation Cross	$\frac{Q_1}{Q_2} = \frac{A_2 - A_{\text{avg}}}{A_{\text{avg}} - A_1}$	Ratio of quantities matches inverted distance to mean
Repeated Dilution	$C_{\text{final}} = C_{\text{initial}}(1 - \frac{x}{V})^n$	Tracks the concentration of the original component

Commercial Interest, Profit & Loss

CONCEPT / TARGET	PRIMARY MATHEMATICAL FORMULA	OPERATIONAL DIRECT FORM
CI Compound Amount	$A = P(1 + \frac{r}{100})^t$	Effective Multiplier applied exponentially across cycles

CONCEPT / TARGET	PRIMARY MATHEMATICAL FORMULA	OPERATIONAL DIRECT FORM
CI/SI 2-Yr Diff	$\Delta_{2Y} = P(1+r)^2$	Equal to interest calculated on the first year's interest
CI/SI 3-Yr Diff	$\Delta_{3Y} = P(1+r)^2 \times (3 + r)$	Extends 2-year difference into a third-year compounding step
Cheating Merchant Profit	$\text{Profit}\% = \frac{\text{True Wt} - \text{Faulty Wt}}{\text{Faulty Wt}} \times 100$	Inversely matches the scale of delivered material

Kinematics & Work Dynamics

CONCEPT / TARGET	PRIMARY MATHEMATICAL FORMULA	OPERATIONAL DIRECT FORM
Average Speed (Equal D)	$S_{\text{avg}} = \frac{2S_1S_2}{S_1 + S_2}$	Harmonic mean of speeds across equal distance components
Average Speed (Equal T)	$S_{\text{avg}} = \frac{S_1 + S_2}{2}$	Arithmetic mean of speeds across equal time components
Relative Speed (Same Dir)	$S_{\text{eff}} = S_1 - S_2$	Rate of change of the separation gap between objects
Relative Speed (Opp Dir)	$S_{\text{eff}} = S_1 + S_2$	Rate of closure or divergence between objects
Work, Men, Days Matrix	$M_1 \cdot D_1 \cdot H_1 \cdot W_1 = M_2 \cdot D_2 \cdot H_2 \cdot W_2$	Total efficiency units balanced against workload values

4. CAT Trap Master List: Top 20 Flaws

Trap 1: The Percentages Reverse Blindspot

Flawed Approach: Assuming a 25% decline from an inflated value strips away the original absolute value increase.

Correct Approach: Multipliers are asymmetric. An increase of 25% ($\times 1.25$) requires a reduction of 20% ($\times 0.8$) to return to baseline ($1.25 \times 0.8 = 1.0$).

CAT Paradigm: Stock increases by 25%, then drops 25%. Net is a 6.25% loss, not 0%.

Trap 2: Average Speed Arithmetic Illusion

Flawed Approach: Calculating the average speed for a round trip as the basic arithmetic mean: $(S_1 + S_2)/2$.

Correct Approach: Because distance is constant, speed is inversely proportional to time. You must use the harmonic mean: $2S_1S_2/(S_1 + S_2)$.

CAT Paradigm: Driving to a station at 40 km/h and returning at 60 km/h yields an average speed of 48 km/h, not 50 km/h.

Trap 3: Circular Tracks First Meeting Point Miscalculation

Flawed Approach: Assuming the first meeting point at the starting location is identical to the absolute first meeting point on the track.

Correct Approach: They meet anywhere on the track in time $T = \text{Length}/S_{\text{rel}}$. They meet specifically at the starting line at $\text{LCM}(T_1, T_2)$.

CAT Paradigm: Runners cross paths multiple times before ever meeting at the starting block simultaneously.

Trap 4: Simple Interest Multi-Year Compounding Error

Flawed Approach: Compounding interest sums during multi-stage Simple Interest problems.

Correct Approach: Simple Interest always accumulates on the baseline initial principal, never on intermediate accrued totals.

CAT Paradigm: Sum doubles in 5 years under SI. It will take 15 years to quadruple (adding 300% principal), not 10 years.

Trap 5: Time and Work Worker Departures

Flawed Approach: Linearly dividing total workload by basic headcounts without tracking staggered timelines.

Correct Approach: Solve using discrete efficiency units per day. Track total units produced before a worker exits, then reallocate the remaining units.

CAT Paradigm: A and B work together for 3 days before A leaves. The units completed must be subtracted from the total before calculating B's remaining time.

Trap 6: Faulty Weight Base Disconnect

Flawed Approach: Calculating profit margin on the targeted weight rather than the actual delivered weight.

Correct Approach: The cost incurred by the merchant corresponds directly to the lower weight actually delivered.

Profit = (True - Faulty) / Faulty.

CAT Paradigm: Giving 800g instead of 1kg yields a profit of $200/800 = 25\%$, not 20%.

Trap 7: Successive Discounts Fallacy

Flawed Approach: Linearly adding sequential discount rates (e.g., $20\% + 30\% = 50\%$ discount).

Correct Approach: Discounts apply successively. Multiplier = $0.8 \text{ times } 0.7 = 0.56$, meaning the net effective discount is 44%.

CAT Paradigm: Retail promotions use stacked phrasing to mask lower absolute structural discounts.

Trap 8: Train Crossing Absolute Length Blindspot

Flawed Approach: Ignoring a train's physical length when it passes a large architectural asset like a platform or bridge.

Correct Approach: Total distance covered during the crossing equals the length of the train plus the length of the asset: $D = L_{\text{train}} + L_{\text{platform}}$.

CAT Paradigm: A 200m train crossing a 300m platform must travel 500m total to clear it completely.

Trap 9: Escalator Steps Reference Frame Disconnect

Flawed Approach: Adding or subtracting raw speeds without accounting for the structural steps built into the escalator frame.

Correct Approach: Total visible steps remain constant. Equate work equations: $Total\ Steps = Time \times (S_{\text{man}} + S_{\text{escalator}})$.

CAT Paradigm: Walking up a moving escalator takes fewer steps because the mechanism covers part of the physical distance.

Trap 10: Constant Component Shifts in Mixtures

Flawed Approach: Tracking changes in the component being added or removed, rather than the component that remains untouched.

Correct Approach: Set up an equation using the absolute quantity of the inactive substance, which stays constant across the entire transaction.

CAT Paradigm: Evaporating water from a salt solution means the absolute mass of salt remains identical from start to finish.

Trap 11: Linear Races Headstart Edge Case

Flawed Approach: Confusing a headstart in distance with a headstart in time.

Correct Approach: A distance headstart means Runner B starts x meters ahead. A time headstart means Runner B starts t seconds earlier.

CAT Paradigm: "A gives B a 100m start" vs. "A gives B a 10-second start"—each requires a completely distinct algebraic setup.

Trap 12: Weighted Average Ratio Inversion

Flawed Approach: Accidentally swapping the quantity weights when setting up the inverse alligation ratio.

Correct Approach: The ratio of quantities is inversely proportional to the distance between their individual values and the combined mean.

CAT Paradigm: Mixing a high-priced item with a low-priced item requires a larger quantity of the low-priced item to pull the average down.

Trap 13: CI Installments Present Value Confusion

Flawed Approach: Dividing the total accumulated principal and interest evenly by the number of installment periods.

Correct Approach: Each installment must be discounted back to its Present Value (PV) based on its specific point in time: $P = \sum [X / (1 + r/100)^t]$.

CAT Paradigm: Equal annual payments account for declining principal balances over time.

Trap 14: Upstream / Downstream Velocity Swap

Flawed Approach: Using the stream's speed as the direct baseline rate in time equations.

Correct Approach: Always use the combined rates: Downstream is $u + v$, Upstream is $u - v$. Never isolate v without factoring in boat velocity.

CAT Paradigm: A boat traveling upstream takes longer because the effective speed is reduced by the current.

Trap 15: Partner Join/Exit Timeline Discrepancies

Flawed Approach: Multiplying capital investments by incorrect time periods during multi-stage partnership shifts.

Correct Approach: Track capital based on the exact number of months it remained active in the business, not the total duration of the venture.

CAT Paradigm: If a partner joins 4 months after launch, their capital is active for only 8 months of a 12-month fiscal year.

Trap 16: Multi-Component Replacement Formula Misapplication

Flawed Approach: Using the standard dilution formula when multiple distinct fluids are drawn out and replaced simultaneously.

Correct Approach: The standard formula works only if the replacement fluid is completely pure and contains none of the original compound.

CAT Paradigm: Replacing a mixture with a pre-blended solution requires a step-by-step concentration tracking approach.

Trap 17: Multi-Pipe Cistern Staggered Overflows

Flawed Approach: Assuming all inlet and outlet pipes operate concurrently across the entire duration of the problem.

Correct Approach: Create a precise timeline of events. Calculate net efficiency step-by-step as pipes open or close.

CAT Paradigm: An outlet valve left open for the first two hours delays the overall filling process by a specific, calculable volume.

Trap 18: Consecutive Year Gains Base Compounding Shift

Flawed Approach: Evaluating growth over multiple years as a simple linear calculation on the original starting value.

Correct Approach: Year-over-year percentage gains compound sequentially, with each new year's growth building on the previous year's closing total.

CAT Paradigm: Population growth or financial asset compounding must be modeled using geometric progressions.

Trap 19: Constant Perimeter Area Optimization Distortion

Flawed Approach: Assuming any rectangular geometry with a fixed perimeter yields the same area regardless of dimensions.

Correct Approach: For a fixed perimeter, a rectangle achieves its maximum possible area when it is a perfect square (Length = Width).

CAT Paradigm: Fencing problems test maximum area boundaries using basic optimization constraints.

Trap 20: Clocks Relative Angular Speed Inversion

Flawed Approach: Treating the minute and hour hands as if they move at the same speed, or ignoring the hour hand's movement entirely.

Correct Approach: The minute hand moves at $6^\circ/\text{min}$, while the hour hand moves at $0.5^\circ/\text{min}$. Their relative speed is exactly $5.5^\circ/\text{min}$.

CAT Paradigm: Calculating the precise time hands overlap requires using their relative angular speed.

5. Speed Techniques & Mental Math Shortcuts

Vedic Math Shortcuts for Arithmetic

Speed in CAT Arithmetic relies on avoiding scratchpad clutter. Implement these mental frameworks to save crucial seconds:

- **Base Multiplication (Near 100):** To multiply numbers close to 100, such as 103 times 107: Find deviations from 100: +3 and +7. Add one deviation to the opposite number: $103 + 7 = 110$. Multiply this by 100 $\rightarrow 11000$. Multiply the deviations: $3 \times 7 = 21$. Sum them up: $11000 + 21 = 11021$.
- **Antimayoreva (Squaring numbers ending in 5):** To square a number like 75: Take the leading digit (7) and multiply it by its successor ($7 \times 8 = 56$). Append 25 to the end. Result = 5625.

Ratio-Fraction Equivalence Shortcuts

Never compute percentages via long division. Convert them instantly to fractions to simplify your equations:

$25\% = \frac{1}{4}$; $33.33\% = \frac{1}{3}$; $16.66\% = \frac{1}{6}$; $14.28\% = \frac{1}{7}$;
 $12.5\% = \frac{1}{8}$; $11.11\% = \frac{1}{9}$; $8.33\% = \frac{1}{12}$

Application: If a price increases by 14.28%, the new price is simply $\frac{8}{7}$ times CP. To return to the original cost, reduce the new price by $\frac{1}{8}$, which is an instant 12.5% reduction.

6. Quick Revision Cards

REVISION CARD 1: PERCENTAGES, PROFIT & LOSS

Core Equations: $\text{Net}\% = a + b + \frac{ab}{100}$ | $SP = CP \times \text{Multiplier}$

Key Fractions: $1/6 = 16.66\%$, $1/7 = 14.28\%$, $1/9 = 11.11\%$, $1/11 = 9.09\%$

Critical Trap: A profit margin of 20% on selling price corresponds to a 25% markup on cost price. Always verify your baseline value.

REVISION CARD 2: TIME, SPEED & DISTANCE

Core Equations: $D = S \times T$ | Same direction: $S_1 - S_2$ | Opposite direction: $S_1 + S_2$

Proportionality: Constant Distance $\rightarrow S \propto \frac{1}{T}$. Constant Time $\rightarrow D \propto S$.

Critical Trap: Average speed across equal distances requires the harmonic mean ($\frac{2S_1S_2}{S_1+S_2}$), not the arithmetic mean.

REVISION CARD 3: TIME & WORK / PIPES

Core Equations: Total Work = Efficiency \times Time | $\frac{M_1 D_1}{W_1} = \frac{M_2 D_2}{W_2}$

Methodology: Use the LCM method to assign an absolute unit value to total work, bypassing fraction additions.

Critical Trap: For leaks or drainage valves, subtract their efficiency units from the net hourly production total.

REVISION CARD 4: MIXTURES & ALLIGATIONS

Core Equations: $\frac{Q_1}{Q_2} = \frac{A_2 - A_{avg}}{A_{avg} - A_1}$ | Dilution: $Left = Total(1 - \frac{x}{V})^n$

Methodology: Apply the alligation cross method to solve weighted average problems quickly.

Critical Trap: Ensure all values use the same baseline units (e.g., compare cost price to cost price, never cost price to selling price).

7. Appendix: Quantitative Foundations**Table of Squares (1–30) & Cubes (1–20)**

N	SQUARE (N ²)	CUBE (N ³)	N	SQUARE (N ²)	CUBE (N ³)
1	1	1	16	256	4096
2	4	8	17	289	4913
3	9	27	18	324	5832
4	16	64	19	361	6859
5	25	125	20	400	8000
6	36	216	21	441	-
7	49	343	22	484	-
8	64	512	23	529	-
9	81	729	24	576	-
10	100	1000	25	625	-
11	121	1331	26	676	-
12	144	1728	27	729	-
13	169	2197	28	784	-
14	196	2744	29	841	-
15	225	3375	30	900	-

Fraction ↔ Percentage ↔ Reciprocal Master Matrix

FRACTION	PERCENTAGE VALUE	DECIMAL RECIPROCAL	FRACTION	PERCENTAGE VALUE	DECIMAL RECIPROCAL
1/2	50.0%	0.5000	1/12	8.33%	0.0833
1/3	33.33%	0.3333	1/13	7.69%	0.0769
1/4	25.0%	0.2500	1/14	7.14%	0.0714
1/5	20.0%	0.2000	1/15	6.66%	0.0666
1/6	16.66%	0.1666	1/16	6.25%	0.0625
1/7	14.28%	0.1428	1/17	5.88%	0.0588
1/8	12.5%	0.1250	1/18	5.55%	0.0555
1/9	11.11%	0.1111	1/19	5.26%	0.0526
1/10	10.0%	0.1000	1/20	5.0%	0.0500
1/11	9.09%	0.0909	-	-	-

Exponential Powers of 2, 3, and 5

EXPONENT (X)	POWER OF 2 (2 ^X)	POWER OF 3 (3 ^X)	POWER OF 5 (5 ^X)
1	2	3	5
2	4	9	25
3	8	27	125
4	16	81	625
5	32	243	3125
6	64	729	15625
7	128	2187	-
8	256	6561	-
9	512	-	-
10	1024	-	-