MAT QUANTITATIVE APTITUDE FORMULA SHEET

HIGH-YIELD CORE FORMULAE & CONCEPTUAL EXPLANATIONS

The Mathematical Skills section of the MAT exam is highly arithmetic-centric. Speed and calculation efficiency are critical. This formula sheet focuses heavily on high-yield formulas, short-cuts, and concept frameworks across the primary components tested in the MAT exam.

1. Core Arithmetic (The Highest Weightage Domain)

Percentages & Fractional Equivalents

Crucial for speed in calculation. Multiply by fractional values instead of working with raw numbers.

$1/2 = 50\%$ | $1/3 = 33.33\%$ | $1/4 = 25\%$ | $1/5 = 20\%$ | $1/6 = 16.66\%$ | $1/7 = 14.28\%$
$1/8 = 12.5\%$ | $1/9 = 11.11\%$ | $1/11 = 9.09\%$ | $1/12 = 8.33\%$ | $1/15 = 6.66\%$

Successive Percentage Change: If a value is changed by $a\%$ and then by $b\%$, the net percentage change is given by:
$Net\ Change = a + b + (ab / 100)\ \%$ (Use negative sign for reduction/discount).

Profit, Loss & Discount

- $Profit\ \% = (Profit / CP) \times 100$ | $Loss\ \% = (Loss / CP) \times 100$ (Always calculated on Cost Price).
- $Selling\ Price\ (SP) = CP \times [1 + (Profit\%/100)]$ or $CP \times [1 - (Loss\%/100)]$.
- $Discount = Marked\ Price\ (MP) - Selling\ Price\ (SP)$.
- $Discount\ \% = (Discount / MP) \times 100$ (Always calculated on Marked Price).
- **The MP-CP Relationship Formula:** $MP / CP = (100 + Profit\%) / (100 - Discount\%)$. This is a massive time-saver for direct questions.

Simple & Compound Interest

- **Simple Interest (SI):** $SI = (P \times R \times T) / 100$ where P = Principal, R = Rate %, T = Time in years.
- **Compound Interest (CI) Amount:** $A = P \times (1 + R/100)^T$ | $CI = A - P$.
- **Difference Formulas (Highly Tested):**
  - Difference between CI and SI for 2 years: $Diff_2 = P(R/100)^2$
  - Difference between CI and SI for 3 years: $Diff_3 = P(R/100)^2 \times (3 + R/100)$

Ratios, Mixtures & Alligations

Alligation Rule: Used to find the ratio in which two ingredients of different costs are mixed to produce a mixture at a mean price.

$$\text{(Quantity of Cheaper)} / \text{(Quantity of Dearer)} = \text{(Dearer Price - Mean Price)} / \text{(Mean Price - Cheaper Price)}$$

Removal and Replacement Formula: If a vessel contains x units of pure liquid, and y units are taken out and replaced by water, after n operations, the quantity of pure liquid left is:

$$\text{Liquid Left} = x \times (1 - y/x)^n$$

Time, Speed & Distance (TSD)

- $\text{Speed} = \text{Distance} / \text{Time}$ | To convert km/hr to m/s, multiply by $5/18$. To convert m/s to km/hr, multiply by $18/5$.
- **Average Speed:**
  - When distances are equal: $\text{Avg Speed} = 2xy / (x + y)$ where x and y are the speeds.
  - When distances are unequal: $\text{Avg Speed} = \text{Total Distance} / \text{Total Time}$.
- **Relative Speed:** Same direction = $S_1 - S_2$ | Opposite direction = $S_1 + S_2$.
- **Boats and Streams:** Let speed of boat in still water = u, speed of stream = v.
  - Downstream speed (D) = $u + v$ | Upstream speed (U) = $u - v$.
  - Speed of boat $u = (D + U) / 2$ | Speed of stream $v = (D - U) / 2$.

Time and Work

- If a person can do a piece of work in x days, their 1-day work = $1/x$.
- If A can do work in x days and B in y days, together they complete it in: $\text{Time} = xy / (x + y)$ days.
- **The Chain Rule:** $(M_1 \times D_1 \times H_1) / W_1 = (M_2 \times D_2 \times H_2) / W_2$ where M = Men, D = Days, H = Hours, W = Work.
- **Pipes and Cisterns:** Inlet pipes add work (+); Outlet/leakage pipes subtract work (-). Net work per hour = $(1/\text{Inlet}) - (1/\text{Outlet})$.

2. Algebra & Number Systems

Number Systems & Divisibility Rules

- $\textit{Sum of first n natural numbers} = n(n + 1) / 2$
- $\textit{Sum of squares of first n natural numbers} = n(n + 1)(2n + 1) / 6$
- $\textit{Sum of cubes of first n natural numbers} = [n(n + 1) / 2]^2$
- **Divisibility Quick Checks: 3/9:** Sum of digits is divisible by 3/9. | **4:** Last 2 digits divisible by 4. | **8:** Last 3 digits divisible by 8. | **11:** (Sum of digits at odd places) - (Sum of digits at even places) must yield 0 or a multiple of 11.
- $LCM \times HCF = \textit{Product of the Two Numbers}$ (Applicable for exactly 2 numbers).

Progressions (AP & GP)

Arithmetic Progression (AP): Common difference $d = a_2 - a_1$

- $n^{th}\ \textit{term}\ (T_n) = a + (n - 1)d$
- $\textit{Sum of n terms}\ (S_n) = (n / 2) \times [2a + (n - 1)d]$ or $(n / 2) \times (a + l)$ where l is the last term.

Geometric Progression (GP): Common ratio $r = a_2 / a_1$

- $n^{th}\ \textit{term}\ (T_n) = a \times r^{(n - 1)}$
- $\textit{Sum of n terms}\ (S_n) = a(r^n - 1) / (r - 1)$ for $r > 1$.
- $\textit{Sum of infinite GP}\ (S_\infty) = a / (1 - r)$ where $|r| < 1$. (Highly targeted concept).

3. Geometry & Mensuration

MAT frequently targets standard direct area and volume formulations. Memorization of basic figures is vital.

2D Shape	Area Formulation	Perimeter / Crucial Identities
Triangle	$Area = \frac{1}{2} \times Base \times Height$ $Heron's: \sqrt{[s(s-a)(s-b)(s-c)]}$	Semi-perimeter $s = (a + b + c) / 2$ Equilateral Area = $(\sqrt{3}/4)a^2$
Circle	$Area = \pi r^2$	Circumference = $2\pi r$ | Arc Length = $(\theta/360) \times 2\pi r$
Quadrilaterals	Rhombus = $\frac{1}{2} \times d_1 \times d_2$ Trapezium = $\frac{1}{2} \times$ (Sum of parallel sides) $\times h$	Square Diagonal = $a\sqrt{2}$ Rectangle Diagonal = $\sqrt{(l^2 + w^2)}$

3D Solid Object	Curved / Lateral Surface Area	Total Volume Formula
Cube / Cuboid	Cuboid LSA = $2h(l + b)$	Cube Vol = a^3 | Cuboid Vol = $l \times b \times h$
Cylinder	$CSA = 2\pi rh$	$Volume = \pi r^2 h$ | $TSA = 2\pi r(h + r)$
Cone	$CSA = \pi rl$ (where $l = \sqrt{(r^2 + h^2)}$)	$Volume = (1/3)\pi r^2 h$
Sphere	$Surface\ Area = 4\pi r^2$	$Volume = (4/3)\pi r^3$ | Hemisphere Vol = $(2/3)\pi r^3$

4. Modern Mathematics Fundamentals

Permutations & Combinations (P&C) & Probability

- **Factorial Definition:** $n! = n \times (n-1) \times (n-2) \times ... \times 1$ | Note: $0! = 1$.
- **Permutation (Arrangement when order matters):** ${}^nP_r = n! / (n - r)!$
- **Combination (Selection when order does not matter):** ${}^nC_r = n! / [r! \times (n - r)!]$
- **Probability Matrix:** $P(A) = Number\ of\ Favorable\ Outcomes\ [n(E)] / Total\ Number\ of\ Outcomes\ [n(S)]$.
- Value of Probability $P(A)$ always satisfies: $0 \le P(A) \le 1$.