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Aptitude Formulas & Short Tricks

Every formula worth memorising for a quantitative aptitude test, plus the shortcuts that turn a two-minute question into a twenty-second one.

[Quantitative aptitude](#)[Maths short tricks](#)[Printable cheat sheet](#)[Free](#)

Percentages

x% of y	$xy / 100$
Change %	$(\text{New} - \text{Old}) / \text{Old} \times 100$
A is x% more than B $\Rightarrow$ B is less by	$x / (100 + x) \times 100 \%$
A is x% less than B $\Rightarrow$ B is more by	$x / (100 - x) \times 100 \%$
Two successive changes a%, b%	$a + b + ab/100$

THE REVERSAL TRAP

Increase by x%, then decrease by x% is **never** break-even.
Net change = $-x^2/100 \%$, always a loss. A 20% rise then 20% fall leaves you at 96%.

Learn the fraction table below. Converting 37.5% to 3/8 turns a long multiplication into one step, and most percentage questions are built on these values.

%	Fraction	%	Fraction
50%	1/2	12.5%	1/8
33.33%	1/3	11.11%	1/9
25%	1/4	9.09%	1/11
20%	1/5	8.33%	1/12
16.67%	1/6	6.25%	1/16
14.28%	1/7	4%	1/25

Profit & Loss

Profit %	$(SP - CP) / CP \times 100$
SP from CP	$CP \times (100 + P) / 100$
CP from SP	$100 \times SP / (100 + P)$
Discount %	$(MP - SP) / MP \times 100$
Two successive discounts a%, b%	$a + b - ab/100$

EQUAL SP, EQUAL $\pm X\%$

Sell two items at the same price, one at +x% and one at -x%, and the result is **always a loss** of $x^2/100 \%$. At $\pm 10\%$ you lose 1%, never break even.

FALSE WEIGHT

Gain % = $\text{Error} / (\text{True value} - \text{Error}) \times 100$. A shopkeeper using a 900 g 'kilo' gains $100/900 \times 100 = 11.11\%$, not 10%.

Simple & Compound Interest

SI	$P \times R \times T / 100$
Amount (CI)	$P (1 + R/100)^n$
CI	$\text{Amount} - P$
Half-yearly	rate $R/2$, periods $2n$
Quarterly	rate $R/4$, periods $4n$
CI - SI (2 years)	$P (R/100)^2$
CI - SI (3 years)	$P (R/100)^2 \times (R/100 + 3)$

WHY CI BEATS SI

Simple interest is paid on the principal only; compound interest is paid on interest too. For 2 years the entire gap is one year's interest on the first year's interest, which is exactly $P(R/100)^2$.

Ratio, Proportion & Partnership

$a : b = c : d \Rightarrow$	$ad = bc$
Mean proportional of a, b	$\sqrt{ab}$
Divide N in a : b	$Na/(a+b), Nb/(a+b)$
Profit share	$\propto \text{capital} \times \text{time}$

ALLIGATION

Cheaper qty : Dearer qty = (Dearer - Mean) : (Mean - Cheaper). Draw a cross, subtract diagonally, and any two-mixture question becomes one subtraction.

Alligation works for any weighted average: price, speed, concentration, marks. If you can write it as 'two groups combining to an average', alligation applies.

Averages & Mixtures

Average	$\text{Sum} / \text{Count}$
New average after adding x	shifts by $(x - \text{old avg}) / (n+1)$
Replacement (remove a, add b)	average changes by $(b - a) / n$
Pure liquid left after n draws of y from x	$x (1 - y/x)^n$

DEVIATION METHOD

Never add long lists. Pick a convenient base, add only the deviations, divide, then add the base back. For 97, 102, 99, 104 take base 100: deviations $+(-3+2-1+4)=2$, so average = $100 + 2/4 = 100.5$.

Time & Work

A alone in a days $\Rightarrow$ 1 day work	$1/a$
A and B together	$ab/(a+b)$ days
Work equation	$M_1 D_1 H_1 / W_1 = M_2 D_2 H_2 / W_2$
Efficiency $\propto$	$1 / \text{time}$

USE LCM UNITS, NOT FRACTIONS

Let total work = LCM of the given days. If A takes 12 and B takes 18, total = 36 units, A = 3/day, B = 2/day, together 5/day $\Rightarrow$ 7.2 days. No fraction addition at all.

Pipes and cisterns is the same topic: an inlet is positive work, a leak is negative. Add the rates with sign.

Time, Speed & Distance

Speed	Distance / Time
km/h $\rightarrow$ m/s	$\times 5/18$
m/s $\rightarrow$ km/h	$\times 18/5$
Avg speed (equal distance)	$2xy/(x+y)$
Avg speed (equal time)	$(x + y)/2$

EQUAL DISTANCE $\neq$ SIMPLE AVERAGE

Going at 40 and returning at 60 gives 48 km/h, not 50. Use the harmonic mean $2xy/(x+y)$ whenever the **distance** is equal.

Train crosses pole	L / speed
Train crosses platform	$(L + P) / \text{speed}$
Opposite directions	relative speed = $s_1 + s_2$
Same direction	relative speed = $s_1 - s_2$
Downstream	$b + s$
Upstream	$b - s$
Boat speed	$(\text{down} + \text{up})/2$
Stream speed	$(\text{down} - \text{up})/2$

Number System

HCF $\times$ LCM	product of the two numbers
Sum 1..n	$n(n+1)/2$
Sum of squares	$n(n+1)(2n+1)/6$
Sum of cubes	$[n(n+1)/2]^2$
Factors of $a^p \cdot b^q$	$(p+1)(q+1)$

$\div$ by	Test	$\div$ by	Test
2	last digit even	8	last 3 digits $\div$ 8
3	digit sum $\div$ 3	9	digit sum $\div$ 9
4	last 2 digits $\div$ 4	11	alt. digit sums differ by 0 or 11
5	ends 0 or 5	6	$\div$ by 2 and 3

UNIT DIGIT CYCLES IN 4

Powers repeat every 4. For 7^{103} : $103 \div 4$ leaves remainder 3, and the 3rd term of 7,9,3,1 is 3. So the unit digit is 3.

Permutation, Combination & Probability

${}^n\text{Pr}$ (order matters)	$n!/(n-r)!$
${}^n\text{Cr}$ (order does not)	$n!/(r!(n-r)!)$
${}^n\text{Cr}$ identity	${}^n\text{Cr} = {}^n\text{C}(n-r)$
Circular arrangements	$(n - 1)!$
Word with repeats	$n!/(p! q! \dots)$
Probability	favourable / total
P(A or B)	$P(A) + P(B) - P(A \text{ and } B)$
P(not A)	$1 - P(A)$
Independent A and B	$P(A) \times P(B)$

ARRANGE OR SELECT?

Ask whether reordering makes a new outcome. Committee of 3 from 10 is selection (${}^{10}\text{C}_3 = 120$). Ranking 3 winners from 10 is arrangement (${}^{10}\text{P}_3 = 720$).

Algebra & Progressions

$(a + b)^2$	$a^2 + 2ab + b^2$
$(a - b)^2$	$a^2 - 2ab + b^2$
$a^2 - b^2$	$(a + b)(a - b)$
$a^3 + b^3$	$(a + b)(a^2 - ab + b^2)$
$a^3 - b^3$	$(a - b)(a^2 + ab + b^2)$
AP nth term	$a + (n - 1)d$
AP sum	$n/2 [2a + (n - 1)d]$
GP nth term	$a r^{n-1}$
GP sum	$a(r^n - 1)/(r - 1)$
GP infinite sum ($ r < 1$)	$a/(1 - r)$

Quadratic $ax^2 + bx + c = 0$: roots = $[-b \pm \sqrt{b^2 - 4ac}]/2a$, sum = $-b/a$, product = c/a . Discriminant > 0 real and distinct, $= 0$ equal, < 0 imaginary.

Geometry & Mensuration

Triangle area	$\frac{1}{2} \times \text{base} \times \text{height}$
Heron's formula	$\sqrt{s(s-a)(s-b)(s-c)}$
Circle area / circumference	$\pi r^2 / 2\pi r$
Rectangle / square	$l \times b / a^2$
Trapezium	$\frac{1}{2} (\text{sum of parallel sides}) \times h$
Cuboid volume / TSA	$lbh / 2(lb+bh+hl)$
Cube volume / TSA	$a^3 / 6a^2$
Cylinder volume / CSA	$\pi r^2 h / 2\pi r h$
Cone volume / CSA	$\frac{1}{3} \pi r^2 h / \pi r l$
Sphere volume / SA	$4/3 \pi r^3 / 4\pi r^2$

Diagonals: cuboid $\sqrt{l^2+b^2+h^2}$, cube $a\sqrt{3}$, square $a\sqrt{2}$.
Pythagoras triples worth memorising: 3-4-5, 5-12-13, 8-15-17, 7-24-25.

Speed calculation

SQUARES NEAR 50

For 47^2 : $47 = 50 - 3$, so answer = $(25 - 3)|3^2 = 2209$. For 53^2 : $53 = 50 + 3 \Rightarrow (25 + 3)|3^2 = 2809$.

MULTIPLY BY 11

Write the outer digits and add neighbours inward. $43 \times 11 \rightarrow 4$
 $(4+3) \ 3 = 473$. Carry when a pair exceeds 9.

NUMBERS ENDING IN 5

$35^2 = 3 \times 4$ then $25 = 1225$. $85^2 = 8 \times 9$ then $25 = 7225$.

n	n ²	n	n ²	n	n ³
13	169	19	361	6	216
14	196	21	441	7	343
15	225	23	529	8	512
16	256	25	625	9	729
17	289	27	729	11	1331
18	324	29	841	12	1728