

Formula Sheets

Important Formulas for Quantitative Aptitude & Reasoning

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A comprehensive guide for Government Competitive Exams

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Number System

Basic Properties

- **Sum of first n natural numbers:** $n(n+1)/2$
- **Sum of first n odd numbers:** n^2
- **Sum of first n even numbers:** $n(n+1)$
- **Sum of squares of first n natural numbers:** $n(n+1)(2n+1)/6$
- **Sum of cubes of first n natural numbers:** $[n(n+1)/2]^2$

Divisibility Rules

- **Divisible by 2:** Last digit is even
- **Divisible by 3:** Sum of digits divisible by 3
- **Divisible by 4:** Last two digits divisible by 4
- **Divisible by 5:** Last digit is 0 or 5
- **Divisible by 8:** Last three digits divisible by 8
- **Divisible by 9:** Sum of digits divisible by 9
- **Divisible by 11:** Difference of sum of alternate digits divisible by 11

HCF and LCM

- **For two numbers a and b :** $\text{HCF} \times \text{LCM} = a \times b$
 - **LCM of fractions:** LCM of numerators / HCF of denominators
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Percentage

Basic Formulas

- **Percentage:** $(\text{Value}/\text{Total Value}) \times 100$
- **Value from percentage:** $(\text{Percentage}/100) \times \text{Total Value}$
- **Percentage increase:** $[(\text{New Value} - \text{Original Value})/\text{Original Value}] \times 100$
- **Percentage decrease:** $[(\text{Original Value} - \text{New Value})/\text{Original Value}] \times 100$

Important Results

- **If A is $x\%$ more than B :** B is $[x/(100+x)] \times 100\%$ less than A
- **If A is $x\%$ less than B :** B is $[x/(100-x)] \times 100\%$ more than A

- **Successive percentage changes:** If two successive changes of $a\%$ and $b\%$, net change = $a + b + (ab/100)\%$
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Ratio and Proportion

Basic Formulas

- **If $a:b = c:d$:** Then $a/b = c/d$ (Cross multiplication: $ad = bc$)
- **Mean proportional:** If $a:b = b:c$, then $b^2 = ac$, b is mean proportional
- **Third proportional:** If $a:b = b:c$, then c is third proportional to a and b

Properties

- **Componendo:** If $a/b = c/d$, then $(a+b)/b = (c+d)/d$
- **Dividendo:** If $a/b = c/d$, then $(a-b)/b = (c-d)/d$
- **Componendo-Dividendo:** If $a/b = c/d$, then $(a+b)/(a-b) = (c+d)/(c-d)$

Partition

- **Direct proportion:** If quantity Q is divided in ratio $a:b:c$, then parts are $(a/(a+b+c)) \times Q$, $(b/(a+b+c)) \times Q$, $(c/(a+b+c)) \times Q$
 - **Inverse proportion:** If three quantities are in inverse ratio $a:b:c$, they are distributed in ratio $1/a:1/b:1/c$
-

Average

Basic Formula

- **Average:** Sum of all observations / Number of observations
- **Weighted average:** $(w_1x_1 + w_2x_2 + \dots + w_nx_n)/(w_1 + w_2 + \dots + w_n)$

Important Results

- **Average of first n natural numbers:** $(n+1)/2$
- **Average of first n odd numbers:** n
- **Average of first n even numbers:** $n+1$
- **Average of consecutive numbers:** $(\text{First} + \text{Last})/2$

Age Problems

- **Present average age:** If average age of n people is A years, total age = nA
 - **After k years:** Average age = $A + k$
 - **k years ago:** Average age = $A - k$
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Simple Interest & Compound Interest**Simple Interest (SI)**

- $SI = (P \times R \times T)/100$
- **Amount = $P + SI$**
- **P = Principal, R = Rate%, T = Time**

Compound Interest (CI)

- **Amount = $P(1 + R/100)^T$**
- **CI = Amount - Principal**
- **For half-yearly compounding:** $A = P(1 + R/200)^{2T}$
- **For quarterly compounding:** $A = P(1 + R/400)^{4T}$

Important Results

- **Difference between CI and SI for 2 years:** $PR^2/10000$
 - **Difference between CI and SI for 3 years:** $PR^2(300 + R)/1000000$
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Profit and Loss**Basic Formulas**

- **Profit = $SP - CP$**
- **Loss = $CP - SP$**
- **Profit% = $(\text{Profit}/CP) \times 100$**
- **Loss% = $(\text{Loss}/CP) \times 100$**
- **$SP = CP(100 + \text{Profit\%})/100$**
- **$SP = CP(100 - \text{Loss\%})/100$**
- **$CP = SP \times 100/(100 + \text{Profit\%})$**
- **$CP = SP \times 100/(100 - \text{Loss\%})$**

Discount

- **Discount** = **MP - SP**
- **Discount%** = $(\text{Discount}/\text{MP}) \times 100$
- **SP** = $\text{MP}(100 - \text{Discount\%})/100$

Partnership

- **Profit sharing ratio** = **Investment ratio** \times **Time ratio**
 - **For equal time:** Profit ratio = Investment ratio
 - **For equal investment:** Profit ratio = Time ratio
-

Time and Work**Basic Formulas**

- **Work** = **Rate** \times **Time**
- **If A can do work in 'a' days:** A's 1 day work = $1/a$
- **If A and B together can do work in 'd' days:** (A+B)'s 1 day work = $1/d$
- **Combined work:** $1/a + 1/b = 1/d$, where $d = ab/(a+b)$

Pipes and Cisterns

- **Filling pipes:** Add the rates
- **Emptying pipes:** Subtract the rates
- **Net rate** = **Inflow rate** - **Outflow rate**

Wages

- **Wages ratio** = **Work ratio** = **Efficiency ratio**
 - **If efficiency ratio is a:b, time ratio** = **b:a**
-

Time, Speed and Distance**Basic Formulas**

- **Distance** = **Speed** \times **Time**

- **Speed = Distance/Time**
- **Time = Distance/Speed**
- **Average Speed = Total Distance/Total Time**

Unit Conversions

- **km/hr to m/s:** Multiply by 5/18
- **m/s to km/hr:** Multiply by 18/5

Relative Speed

- **Same direction:** Relative speed = $|S_1 - S_2|$
- **Opposite direction:** Relative speed = $S_1 + S_2$

Trains

- **Time to cross a pole/man:** Length of train/Speed of train
- **Time to cross a platform:** (Length of train + Length of platform)/Speed of train
- **Time for two trains to cross each other:** $(L_1 + L_2)/(S_1 + S_2)$ [opposite direction]

Boats and Streams

- **Downstream speed = Boat speed + Stream speed**
 - **Upstream speed = Boat speed - Stream speed**
 - **Boat speed = (Downstream + Upstream)/2**
 - **Stream speed = (Downstream - Upstream)/2**
-

Mensuration

2D Shapes

Rectangle

- **Perimeter = $2(l + b)$**
- **Area = $l \times b$**
- **Diagonal = $\sqrt{l^2 + b^2}$**

Square

- **Perimeter** = $4a$
- **Area** = a^2
- **Diagonal** = $a\sqrt{2}$

Circle

- **Circumference** = $2\pi r$
- **Area** = πr^2
- **Arc length** = $(\theta/360^\circ) \times 2\pi r$
- **Sector area** = $(\theta/360^\circ) \times \pi r^2$

Triangle

- **Area** = $(1/2) \times \text{base} \times \text{height}$
- **Area** = $\sqrt{[s(s-a)(s-b)(s-c)]}$ (Heron's formula)
- $s = (a+b+c)/2$ (semi-perimeter)

Rhombus

- **Area** = $(1/2) \times d_1 \times d_2$ (d_1, d_2 are diagonals)
- **Area** = $\text{base} \times \text{height}$

Trapezium

- **Area** = $(1/2) \times (\text{sum of parallel sides}) \times \text{height}$

3D Shapes

Cube

- **Volume** = a^3
- **Surface area** = $6a^2$
- **Diagonal** = $a\sqrt{3}$

Cuboid

- **Volume** = $l \times b \times h$
- **Surface area** = $2(lb + bh + hl)$
- **Diagonal** = $\sqrt{l^2 + b^2 + h^2}$

Cylinder

- **Volume** = $\pi r^2 h$
- **Curved surface area** = $2\pi r h$
- **Total surface area** = $2\pi r(r + h)$

Cone

- **Volume** = $(1/3)\pi r^2 h$
- **Curved surface area** = $\pi r l$ (l = slant height)
- **Total surface area** = $\pi r(r + l)$
- **Slant height** = $\sqrt{r^2 + h^2}$

Sphere

- **Volume** = $(4/3)\pi r^3$
 - **Surface area** = $4\pi r^2$
-

Algebra

Basic Identities

- $(a + b)^2 = a^2 + 2ab + b^2$
- $(a - b)^2 = a^2 - 2ab + b^2$
- $a^2 - b^2 = (a + b)(a - b)$
- $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$
- $(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$
- $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$
- $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$

Quadratic Equations

- $ax^2 + bx + c = 0$
- **Discriminant (D)** = $b^2 - 4ac$
- **Roots** = $[-b \pm \sqrt{b^2 - 4ac}]/2a$
- **Sum of roots** = $-b/a$
- **Product of roots** = c/a

Arithmetic Progression (AP)

- **nth term:** $a_n = a + (n-1)d$
- **Sum of n terms:** $S = n/2[2a + (n-1)d]$

- Sum of n terms: $S = n/2(\text{first term} + \text{last term})$

Geometric Progression (GP)

- n th term: $a_n = ar^{(n-1)}$
 - Sum of n terms: $S = a(r^n - 1)/(r - 1)$ [$r \neq 1$]
 - Sum to infinity: $S = a/(1-r)$ [$|r| < 1$]
-

Trigonometry

Basic Ratios

- $\sin \theta = \text{opposite/hypotenuse}$
- $\cos \theta = \text{adjacent/hypotenuse}$
- $\tan \theta = \text{opposite/adjacent} = \sin \theta / \cos \theta$
- $\cot \theta = 1/\tan \theta$
- $\sec \theta = 1/\cos \theta$
- $\csc \theta = 1/\sin \theta$

Fundamental Identities

- $\sin^2 \theta + \cos^2 \theta = 1$
- $1 + \tan^2 \theta = \sec^2 \theta$
- $1 + \cot^2 \theta = \csc^2 \theta$

Standard Values

Angle	0°	30°	45°	60°	90°
$\sin \theta$	0	1/2	1/√2	√3/2	1
$\cos \theta$	1	√3/2	1/√2	1/2	0
$\tan \theta$	0	1/√3	1	√3	∞

Statistics

Measures of Central Tendency

- **Mean** = $\Sigma x/n$
- **Median**: Middle value when arranged in order
- **Mode**: Most frequently occurring value

Measures of Dispersion

- **Range** = Maximum value - Minimum value
 - **Mean deviation** = $\Sigma |x - \text{mean}|/n$
 - **Standard deviation** (σ) = $\sqrt{(\Sigma (x - \text{mean})^2/n)}$
 - **Variance** = σ^2
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Probability

Basic Formulas

- **$P(E)$** = Number of favorable outcomes/Total number of outcomes
- **$P(E) + P(E') = 1$** (E' is complement of E)
- **$P(A \cup B) = P(A) + P(B) - P(A \cap B)$**
- **$P(A \cap B) = P(A) \times P(B)$** [for independent events]

Conditional Probability

- **$P(A|B) = P(A \cap B)/P(B)$**
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Permutation and Combination

Basic Formulas

- **$nPr = n!/(n-r)!$** (Permutation)
- **$nCr = n!/(r!(n-r)!)$** (Combination)
- **$nC0 = 1, nCn = 1$**
- **$nCr = nC(n-r)$**
- **$nCr + nC(r-1) = (n+1)Cr$**

Special Cases

- **Circular permutation of n objects** = $(n-1)!$
- **Arrangement of n objects with r identical** = $n!/r!$

Reasoning Formulas

Number Series

- **Arithmetic series:** $a, a+d, a+2d, \dots$ (common difference)
- **Geometric series:** a, ar, ar^2, \dots (common ratio)
- **Square series:** $1^2, 2^2, 3^2, \dots$ or perfect squares
- **Cube series:** $1^3, 2^3, 3^3, \dots$ or perfect cubes

Coding-Decoding

- **Letter position in alphabet:** A=1, B=2, C=3, ..., Z=26
- **Reverse position:** A=26, B=25, C=24, ..., Z=1

Direction and Distance

- **Pythagoras theorem for displacement:** $d = \sqrt{x^2 + y^2}$
- **North/South cancels out East/West components**

Age Relations

- **If A is x years older than B:** A's age = B's age + x
- **After n years:** Everyone's age increases by n
- **Before n years:** Everyone's age decreases by n

Clock Problems

- **Hour hand moves 360° in 12 hours = 30° per hour = 0.5° per minute**
- **Minute hand moves 360° in 60 minutes = 6° per minute**
- **Relative speed = $6^\circ - 0.5^\circ = 5.5^\circ$ per minute**
- **Hands coincide every 12/11 hours**
- **Hands are perpendicular 44 times in 24 hours**

Calendar

- **Leap year:** Divisible by 4 (except century years, which must be divisible by 400)
- **Days in months:** 31 days (Jan, Mar, May, Jul, Aug, Oct, Dec), 30 days (Apr, Jun, Sep, Nov), 28/29 days (Feb)
- **Day of week calculation:** Use remainder when divided by 7

Quick Reference - Important Values**Mathematical Constants**

- $\pi \approx 3.14159$ or $22/7$
- $e \approx 2.718$
- $\sqrt{2} \approx 1.414$
- $\sqrt{3} \approx 1.732$
- $\sqrt{5} \approx 2.236$

Perfect Squares (1-30)

1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, 169, 196, 225, 256, 289, 324, 361, 400, 441, 484, 529, 576, 625, 676, 729, 784, 841, 900

Perfect Cubes (1-20)

1, 8, 27, 64, 125, 216, 343, 512, 729, 1000, 1331, 1728, 2197, 2744, 3375, 4096, 4913, 5832, 6859, 8000

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Note: Practice these formulas regularly and understand their applications. Remember, consistent practice is the key to mastering quantitative aptitude and reasoning sections in competitive exams.