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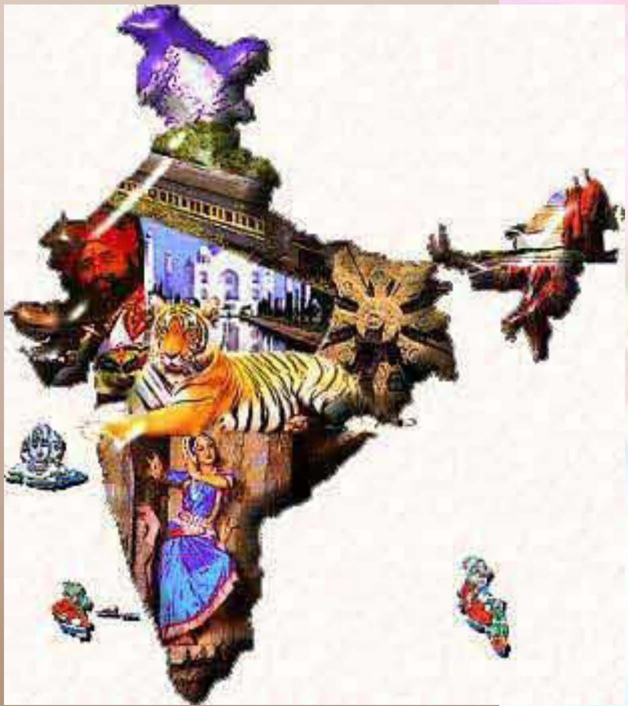
MATHEMATICS



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Maths Formuale Hand Book

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Mathematics Formulae Hand book

SET THEORY

COMMUTATIVE PROPERTY OF UNION OF SET $A \cup B = B \cup A$

COMMUTATIVE PROPERTY OF INTERSECTION OF SETS $A \cap B = B \cap A$

ASSOCIATIVE PROPERTY OF UNION OF SETS

$$A \cup (B \cup C) = (A \cup B) \cup C$$

ASSOCIATIVE PROPERTY OF INTERSECTION OF SETS

$$A \cap (B \cap C) = (A \cap B) \cap C$$

DISTRIBUTIVE PROPERTY (Right) $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$

DISTRIBUTIVE PROPERTY (Left) $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$

DE MORGAN'S LAWS

- $(A \cup B)^1 = A^1 \cap B^1$
- $(A \cap B)^1 = A^1 \cup B^1$

RELATION BETWEEN NUMBERS OF ELEMENTS OF TWO SETS

- $n(A \cup B) = n(A) + n(B) - n(A \cap B)$
- $n(A \cap B) = n(A) + n(B) - n(A \cup B)$
- If A and B are disjoint sets then $A \cap B = \phi$
    - $n(A \cap B) = 0$
    - $n(A \cup B) = n(A) + n(B)$

COMPLEMENT OF SETS

- $A^1 = U - A$
- $B^1 = U - B$
- $(A \cup B)^1 = U - (A \cup B)$
- $(A \cap B)^1 = U - (A \cap B)$

SOME IMPORTANT FORMULAE

- $A \cup \phi = A$
- $A \cap \phi = \phi$
- If $A^{|} = \phi$ then $A = U$
- $A \subseteq B$ then $A^{|} \subseteq B^{|}$
- $A \cup A^{|} = U$ then $A \cap A^{|} = \phi$
- If $A \cap B = \phi$ then $A^{|} \cup B^{|} = U$
- $A - (A - B) = A \cap B$
- If $(A - B) = A$ then $(A \cap B) = \emptyset$
- If B is subset of A then $A \cap B = B$ and $A \cup B = A$

MATRICES

- If the order of a given matrix A is **m x n** then the order of its transpose A^1 is **n x m**
- If **$A = A^1$** then the matrix A is **Symmetric matrix**
- If **$A = -A^1$** then the matrix A is **Skew Symmetric matrix**
- Transpose of a Row matrix is Column Matrix
- If Two matrix are equal then their corresponding elements are equal
- $A + A^1$ is **Symmetric matrix**
- $A - A^1$ is **Skew Symmetric matrix**
- The matrix multiplication AB exists only when the number of Rows of Matrix A are equal to number of columns of Matrix B
- If A and B are two matrixes conformable for multiplication then **$(AB)^1 = B^1A^1$**
- If A is Square matrix and I is the unit matrix of the order A then **AI = IA = A**

SEQUENCE

ARITHMETIC, GEOMETRIC, HARMONIC PROGRESSION

- General form of AP is a, **a+d, a+2d, ------------ a + (n – 1)d**
- **$T_n = a + (n - 1)\, d$** [The general formula of **AP**]
- Find the value of Common Difference $d = \dfrac{(T_p - T_q)}{(p - q)}$ or $\dfrac{T_n - a}{n - 1}$
- To find the Sum of the first 'n' Natural numbers

$$S_n = \frac{n\,(n + 1)}{2}$$

- To find the sum of first 'n' terms of an Arithmetic Progression

$S_n = \frac{n}{2}(a + l)$ when last term is given

$S_n = \frac{n}{2}[2a + (n - 1) d]$ when last term not given

- General form of GP is $a, ar, ar^2,$ ---------------- ar^{n-1}
- $T_n = ar^{n-1}$ [The general formula of **GP**]
- To obtain the succeeding term of a given term in GP $T_{n+1} = T_n \times r$
- To obtain the preceding term of a given term in GP $T_{n-1} = \frac{T_n}{r}$
- To find the sum of First 'n' terms of Finite series

$S_n = \frac{a(1 - r^n)}{(1 - r)}$ when $r < 1$ $\quad Sn = \frac{a(r^n - 1)}{(r - 1)}$ when $r > 1$

- To fine the sum of First 'n' terms of Infinite series

$S_\infty = \frac{a}{(1 - r)}$

- $T_n = \frac{1}{a + (n - 1) d}$ [The general formula of **HP**]
- To find the *Arithmetic mean* $A.M = \frac{a + b}{2}$
- To find the *Geometric mean* $G.M = \sqrt{ab}$
- To find the *Harmonic mean* $H.M = \frac{2ab}{a + b}$
- The relationship between the Arithmetic, Geometric and Harmonic Mean

$G = \sqrt{AH}$ or $G^2 = ab$

- To obtain the succeeding term of a given term in AP $T_{n+1} = T_n + d$
- To obtain the succeeding term of a given term in AP $T_{n-1} = T_n - d$
- $\frac{S_{2n}}{S_n} = r^n + 1$
- $S_n : S_{2n} = 1 : r^{n+1}$
- $S_{2n} : S_{n} = r^{n+1}$

PERMUTATION AND COMBINATIONS

Important formula's related to PERMUTATION

- Formula for number of permutation of 'n' things taken'r' at a time

$${}^nP_r = n\,(n-1)\,(n-2)\text{------------}(n-r+1)$$

- Factorial notation ------ ${}^nP_n = n!$
- In permutation ${}^nP_r$ means the number of permutation of 'n' things taken 'r' at a time
- Important formula's related to permutation
  - ${}^nP_r = \dfrac{n!}{(n-r)!}$
  - $\dfrac{n!}{(n-r)!} = n$
  - $n! = n\,(n-1)!$
  - ${}^nP_n = {}^nP_{n-1}$
  - $0! = 1$
  - $1! = 1$
  - ${}^nP_0 = 1$
  - ${}^nP_2 = n\,(n-1)$
  - ${}^nP_3 = n\,(n-1)\,(n-2)$

Important formula's related to COMBINATIONS

- ${}^nC_r = \dfrac{n!}{(n-r)!r!}$
- ${}^nC_0 = 1$
- ${}^nC_n = 1$
- ${}^nC_r \leq {}^nP_r$
- ${}^nC_1 = {}^nP_1 = 1$
- Relation between ${}^nP_r$ and ${}^nC_r$ is ${}^nP_r = {}^nC_r \times r!$
- ${}^nC_r = {}^nC_{n-r}$
- ${}^nC_r = \dfrac{{}^nPr}{r!}$
- ${}^nC_2 = \dfrac{n\,(n-1)}{2!}$
- ${}^nC_3 = \dfrac{n\,(n-1)\,(n-2)}{3!}$

STATISTICS

FOR UNGROUPED DATA

- Arithmetic Mean

$$X = \frac{\Sigma X}{N}$$

- Variance

$$\sigma^2 = \frac{\Sigma D^2}{N}$$

- Standard Deviation

$$S.D = \sqrt{\frac{\Sigma D^2}{N}}$$

FOR GROUPED DATA

- Arithmetic Mean

$$X = \frac{\Sigma fX}{N}$$

- Variance

$$\sigma^2 = \frac{\Sigma fD^2}{N}$$

- Standard Deviation

$$S.D = \sqrt{\frac{\Sigma fD^2}{N}}$$

COEFFICIENT OF VARIATION

- C. V = $\frac{\sigma}{X} x\ 100$
- Consistency or Variability is determined by the co – efficient of Variation
- Between variables, if C.V is **LESS** then score is **CONSISTENT**
- Between variables if C.V is **MORE** then score is **VARIABLE**

FACTORS AND FACTORISATION

H.C.F AND L.C.M

- Relation between two expressions and their H.C.F and L.C.M

$$A \times B = H \times L$$

- $A = \frac{H \times L}{B}$

- $B = \frac{H \times L}{A}$
- $H = \frac{A \times B}{L}$
- $L = \frac{A \times B}{H}$
- If last remainder is constant and not zero then the HCF of two expressions is **1**

CYCLIC SYMMETRY

- Variables

$a \rightarrow b$	$x \rightarrow y$	$p \rightarrow q$	$m \rightarrow n$
$b \rightarrow c$	$y \rightarrow z$	$q \rightarrow r$	$n \rightarrow o$
$c \rightarrow a$	$z \rightarrow x$	$r \rightarrow p$	$o \rightarrow m$

CONDITIONAL IDENTITIES

- $(a + b)^2 \equiv a^2 + 2ab + b^2$
- $(a - b)^2 \equiv a^2 - 2ab + b^2$
- $(a + b)^3 \equiv a^3 + b^3 + 3ab\,(a + b)$
- $(a - b)^3 \equiv a^3 - b^3 - 3ab\,(a - b)$
- $(a + b + c)^2 \equiv a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$
- $(x + a)(x + b)(x + c) \equiv x^3 + x^2(a + b + c) + x(ab + bc + ca) + abc$
- $(x + a)(x + b) \equiv x^2 + x(a + b) + ab$
- $a^2 - b^2 \equiv (a + b)(a - b)$
- $a^3 + b^3 \equiv (a + b)(a^2 + b^2 - ab)$
- $a^3 - b^3 \equiv (a - b)(a^2 + b^2 + ab)$
- $a^3 + b^3 + c^3 - 3abc \equiv (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ca)$
- $a^4 + a^2b^2 + b^4 \equiv (a^2 + b^2 + ab)(a^2 + b^2 - ab)$

SURDS

- Multiplication of surds having different order

$$\sqrt[n]{a} \times \sqrt[n]{b} = \sqrt[n]{ab}$$

MODULAR ARITHMETIC

- In general the Addition Modulo of two positive integers ‘a’ and ‘b’ is given by

$$a \oplus b = r$$

- In general the Multiplication Modulo of two positive integers 'a' and 'b' is given by

$$a \otimes b = r$$

- "r is the remainder obtained when the sum and product are divided by the mode m"

- **SET OF RESIDUES (Z)**

  In general if any positive integer is divided by 'm' then the Remainders will be represented as one of the following

  i.e., 0, 1, 2, 3, ------------------- (m – 1)

- **CONGRUENCE OF NUMBER (≡)**

  In general $a \equiv b \pmod m$
  → $(a - b) \equiv 0 \pmod m$
  → m divides (a – b)
  i.e. m is a multiple of (a – b)

QUADRATIC EQUATIONS

- If **b = 0** the roots are equal but opposite in sign
- If **a = c** the roots are reciprocal to each other
- If **c = 0** the one root is zero
- A Linear Equation has only **ONE** root
- A quadratic equation has **TWO** roots
- Pure Quadratic Equation $ax^2 + c = 0$
- Standard form of quadratic Equation $ax^2 + bx + c = 0$
- Roots of the Equation $ax^2 + bx + c = 0$ [Sridhar's Method]

$$X = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Nature of roots of Quadratic Equation

$$\Delta = b^2 - 4ac$$

Discriminant $(b^2 - 4ac)$	Nature of the roots
$\Delta = 0$	Roots are Real and Equal
$\Delta > 0$ (Positive)	Roots are Real and Distinct
$\Delta < 0$ (Negative)	Roots are Imaginary

- Relation between the roots and coefficients of the terms of the quadratic equation

$$\text{Sum of the Roots } (m + n) = \frac{-b}{a}$$

$$\text{Product of the Roots } (m - n) = \frac{c}{a}$$

- If 'm' and 'n' are the roots then the standard form of the quadratic equation is

$$X^2 - (\text{sum of the roots})\, x + \text{Product of the roots} = 0$$

$$x^2 - (m + n)\, x + mn = 0$$

GRAPH

- The Graph of a Quadratic Polynomial is a curve called **PARABOLA**
- The graph of a linear equation is **STRAIGHT LINE**

PRACTICAL GEOMETRY

- Radius $r = \frac{d}{2}$
- Diameter $d = 2r$
- Circumference of circle $C = 2\pi r$
- Minor Arc subtends **ACUTE** angle
- Semi circle subtends **RIGHT** angle
- Major Arc subtends **OBTUSE** angle
- Distance between the centers of two circles of different radii to draw a **Direct Common Tangent**

  $d = (R - r)$
- Distance between the centers of two circles of different radii to draw a **Transverse Common Tangent**

$d = (R + r)$

- **CIRCLE** – The locus of a point moving on a plane such that it is always at a constant distance from the fixed point
- **CIRCUMFERENCE** – Length of the closed curved line which makes the circle
- **RADIUS** - The line segment joining the center and any point on the circle
- **CHORD** - The line segment joining any two points on the circle
- **DIAMETER** – A Chord that passes through the center of the circle
- **ARC** – Part of a Circle
- Equal Chords are **Equidistant** from the center
- **SEGMENT** – The region bounded by the chord and arc
- **CONCENTRIC CIRCLES** – Circles having the same center but different radii
- **CONGRUENT CIRCLES** – Circles having equal radii but different centers
- **SECANT** – A straight line which cuts the circle at two distinct points
- **TANGENT** – A straight line that meets the circle at one and only one point
- The radius drawn at the point of contact is **perpendicular** to the tangent
- Length of tangent from an external point $t = \sqrt{d^2 - r^2}$
- Length of Direct Common Tangent $t = \sqrt{d^2 - (R - r)^2}$
- Length of Transverse common tangent $t = \sqrt{d^2 - (R + r)^2}$
- Angles in the same segment of a circle are equal
- Only **2** tangents can be drawn to a circle from an external point

NATURE	Total Common Tangent	DCT	TCT	Circles are
$d > R + r$	4	2	2	Separated
$d = R + r$	3	2	1	External Touch
$d < R + r$	2	2	0	Intersect
$d = R - r$	1	1	0	Internal Touch
$d < R - r$	0	0	0	One within other
$d = 0$	0	0	0	Concentric

THEOREMS ON TRIANGLES AND CIRCLES

- **PROPORTIONALITY**

If two ratios are equal, then they are said to be in proportion

$a : b = c : d$ or $\frac{a}{b} = \frac{c}{d}$

- **BASIC PROPORTIONALITY THEOREM [Thales Theorem]**

A straight-line drawn parallel to a side of a triangle, divides the other two sides proportionately

- **CONVERSE OF BASIC PROPORTIONALITY THEOREM**
  If a line divides two sides of a triangle proportionately, the line parallel to the third side of the triangle
- **CORROLLARY OF BASIC PROPORTIONALITY THEOREM**

If a line is drawn parallel to a side of a triangle then the sides of the new triangle formed are proportional to the sides of the given triangle

- **SIMILARITY OF TRIANGLES** $\frac{AB}{DE} = \frac{BC}{EF} = \frac{CA}{FD}$

If two triangles are equiangular then their corresponding sides are proportional

- **AREAS OF SIMILAR TRIANGLES**

The areas of similar triangle are proportional to the square of the corresponding sides

$$\frac{\text{Area of } \Delta ABC}{\text{Area of } \Delta DEF} = \frac{BC^2}{EF^2}$$

- **RIGHT ANGLED TRIANGLE [Pythagoras Theorem]**

In a right-angled triangle, the square on the hypotenuse is equal to the sum of the squares on the remaining sides.

$$BC^2 = AB^2 + AC^2$$

- **BAUDHAYANA THEOREM**

The diagonal of the rectangle produces both areas which its length and breadth produce Separately

- **CONVERSE OF PYTHAGORAS THEOREM**

If the square on one side of a triangle is equal to the sum of the square on the other two sides, then those two sides contain a right angle

- **DISTANCE BETWEEN THE CENTRES OF TOUCHING CIRCLES**
- If two circles touch each other **EXTERNALLY,** the distance between their centers is equal to the sum of their radii

$$d = [R + r]$$

- If two circles touch each other **INTERNALLY,** the distance between their centers is equal to the difference of their radii

$$d = [R - r]$$

- **PROPERTIES OF TANGENTS DRAWN TO CIRCLE FROM EXTERNAL POINT**

1. The tangents are equal
2. The tangents make equal angles with the line joining the centers and the external point

3. The angles between the radius and the line joining the center and the external point are equal

MENSURATION

RIGHT CIRCULAR CYLINDER, CONE ,SPHERE, HEMISPHERE

SOLID	Curved/Lateral surface Area	Total Surface Area	Volume
CYLINDER	$2\pi rh$	$2\pi r (r + h)$	$\pi r^2 h$
CONE	πrl	$\pi r (r + l)$	$\frac{1}{3} \pi r^2 h$
SPHERE	$4\pi r^2$	$4\pi r^2$	$\frac{4}{3} \pi r^3$
HEMISPHERE	$2\pi r^2$	$3\pi r^2$	$\frac{2}{3} \pi r^3$

Where

- **r** = Radius
- **l** = Slant height
- **h** = Height
- **π** = Circumference of the circle, whose value is 3.1416 or 22/7
- Some related formula's [To find Slant height]
- Area of Circular base = πr^2

  - $l^2 = r^2 + h^2$
  - $l = \pm\sqrt{r^2 + h^2}$
  - $h = \pm\sqrt{l^2 - r^2}$
  - $r = \pm\sqrt{l^2 - h^2}$

SCALE DRAWING

- To find the Area of Triangle

$$A = \frac{1}{2} \times \text{base} \times \text{height} \qquad [A = \frac{1}{2} bh]$$

- To find the Area of Rectangle

A = Length x Breadth [A = lb]

- To find the Area of Trapezium

$$A = \frac{1}{2} \times \text{height} \times (\text{sum of two parallel sides}) \quad [A = \frac{1}{2} \times h\,(a + b)]$$

- Area of land is measured in Hectares

Where

1 Hectare = 10, 000 Sq mts.

POLYHEDRA AND NETWORKS

- **EULER'S FORMULA FOR POLYGONS**

F + V = E + 2

Where F = Faces
V = Vertices
E = Edges

- **EULER'S FORMULA FOR GRAPHS**

N + R = A + 2

Where N = Nodes
R = Regions
A = Arcs

- **CONDITION FOR TRAVERSABILITY OF GRAPH**

  - A Graph is Traversable if it has only **EVEN** nodes
  - A Graph is Traversable if it has only **TWO ODD** nodes
  - A Graph is not traversable if it has more than **TWO ODD** nodes.

- PLATONIC SOLIDS

1. Tetrahedron – Equilateral Triangle
2. Hexahedron – Square
3. Octahedron – Equilateral triangle
4. Dodecahedron – Regular Pentagon
5. Icosahedrons – Equilateral triangle

- **POLYGON** – A closed figure bounded by straight line segments
- **REGULAR POLYGON** – It is a polygon having equal sides and equal angles
- **POLYHEDRON** – A closed figure in the space bounded by polygonal faces.
- **POLYHEDRAL SOLID** – A solid bounded by a polyhedron.
- **REGULAR POLYHEDRA** – its faces are congruent regular polygons
- **GRAPH** – A set of points together with line segments joining the points in pairs
- **NODES IN GRAPH** – A point is a node if there is atleast one path starting from it or reaching it.
- **ARC IN A GRAPH** – The line segment joining two nodes.
- **REGION** – An area bounded by arcs (including outside)

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