FORMULA BOOKLET

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Some important formulae

1. Algebraic formulae

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

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

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

$(a+b+c)^2=a^2+b^2+c^2+2ab+2bc+2ca$

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

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

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

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

2. Laws of Indices If a and b are non-zero rational numbers and m and n are rational numbers, then:

$a^0=1$

$a^{-m}=\frac{1}{a^m}$

$\sqrt[m]{a}=a^{\frac{1}{m}}$

$a^{\frac{n}{m}}=\sqrt[m]{a^n}$

$a^m \times a^n = a^{m+n}$

$a^m \div a^n = a^{m-n}$

$(a^m)^n = amn$

$(ab)m = a^m b^m$

$am^n = a^{(m^n)}$

3. Laws of Logarithms

$\log x1 = 0$

$\log aa = 1$

$\log x\, a \times \log ax = 1$

$\log x\,(m \times n) = \log xm + \log xn$

$\log m \div n() = \log xm - \log xn$

$\log x(m)^n = n\log xm$

$\log xm = \frac{\log am}{\log x} = \log am \times \log xa$

$x\log xm = m$

If $\log xm = \log ym$, then, $x = y$

If $\log xm = \log xn$, then, $m = n$

4. Sum of important series

Sum of first n natural numbers

$1 + 2 + 3 + \ldots + n = \frac{n(n+1)}{2}$

Sum of the squares of the first n natural numbers

$1^2+2^2+3^2+\ldots+n^2 = \frac{n(n+1)(2n+1)}{6}$

Sum of the cubes of the first n natural numbers

$1^3+2^3+3^3+\ldots+n^3 = [\frac{n(n+1)}{2}]^2$

5. Arithmetic Progression

For an arithmetic progression (A.P.) whose first term is a and the common difference isd:

nth term= $t_n = a + (n-1)d$

The sum of the first n terms = $S_n = \frac{n}{2}(a+l) = \frac{n}{2}(2a + (n-1)d)$ where l =last term= $a + (n-1)d$

6. Geometric Progression

For a geometric progression (G.P.) whose first term is a and the common ratio is r:

nthterm= $t_n = ar^{n-1}$

The sum of the first n terms:

$$S_n = \begin{cases} \frac{a(1-r^n)}{(1-r)} & r < 1 \\ \frac{a(r^n-1)}{(r-1)} & r > 1 \\ na & r = 1 \end{cases}$$

7. Mean

Arithmetic mean $= \frac{a_1 + a_2 + \ldots + a_m}{m}$

For two numbers x and y , arithmetic mean = $\frac{x+y}{2}$.

Geometric mean $= \sqrt[m]{a_1 \times a_2 \times \cdots \times a_m}$

For two numbers x and y , geometric mean = $\sqrt{xy}$.

Harmonic mean $= \frac{m}{\frac{1}{a_1} + \frac{1}{a_2} + \ldots + \frac{1}{a_m}}$

For two numbers x and y , harmonic mean = $\frac{2xy}{x+y}$

8. Percentages

Percentage Increase $= \frac{\text{Actual increase}}{\text{Original quantity}} \times 100$

Percentage Decrease $= \frac{\text{Actual decrease}}{\text{Original quantity}} \times 100$

Fraction	Percentage (%)	Fraction	Percentage (%)
1/2	50	1/9	11.11
1/3	33.33	1/10	10
1/4	25	1/11	9.09
1/5	20	1/12	8.33
1/6	16.66	1/13	7.69
1/7	14.28	1/14	7.14
1/8	12.5	1/15	6.66

9. Profit and Loss

Profit= Selling Price – Cost Price= SP-CP

Percentage Profit = $\frac{\text{Profit}}{\text{CP}} \times 100$

Loss= CP-SP

Percentage Loss= $\frac{\text{Loss}}{\text{CP}} \times 100$

10. Interest

Simple Interest = $\frac{\text{Principal} \times \text{Rate} \times \text{Time}}{100} = \frac{P \times R \times N}{100}$

Compound Interest = $P \times \left(1 + \frac{R}{100}\right)^N - P$

Amount= Principal + Interest

11. Averages

Simple Average= $\frac{\text{Sum of elements}}{\text{Number of elements}}$

Weighted Average= $\frac{w_1a_1 + w_2a_2 + \ldots + w_ma_m}{w_1 + w_2 + \ldots + w_m}$

12. Successive Replacement

$\frac{\text{Quantity of milk remaining after nth replacement}}{\text{Quantity of total mixture}} = \left(\frac{x-y}{x}\right)^n$

Where x is the original quantity, y is the quantity that is replaced and n is the number of times the replacement process is carried out.

13. Prop ortions

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

$\frac{a}{c} = \frac{b}{d}$ ⋯AlternendoLaw

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

:::ComponendoLaw

:::DividendoLaw

$\frac{a+b}{b} = \frac{c+d}{d}$

$\frac{a-b}{b} = \frac{c-d}{d}$

$\frac{a+b}{a-b} = \frac{c+d}{c-d}$ … ComponendoandDividendoLaw

$\frac{a}{b} = \frac{c}{d} = \frac{e}{f} = \cdots = k$, then $a+c+e+\cdots = k$

$\frac{a}{b} = \frac{c}{d} = \frac{e}{f} = \cdots = k$, and p, q, rare real numbers, then

$\frac{pa^n + qc^n + re^n + \ldots}{pb^n + qd^n + rf^n + \ldots} = k^n$

14. Quadratic formulae

The roots of the quadratic equation $ax^2+bx+c=0; a \neq 0$ are $\frac{-b \pm \sqrt{b^2-4ac}}{2a}$

The solution set of the equation is $\{\frac{-b+\sqrt{\Delta}}{2a}, \frac{-b-\sqrt{\Delta}}{2a}\}$,

where Δ = discriminant = $b^2 - 4ac$

The roots are real and distinct if Δ > 0

The roots are real and coincident if Δ = 0

The roots are non-real if Δ < 0

If α and β are the roots of the equation $ax^2+bx+c=0, a \neq 0$ then

i.)$\alpha+\beta=-b=\frac{-\text{co-efficient of } x}{a}$ co-efficient of x^2

ii.)$\alpha \cdot \beta=c=\frac{\text{constant term}}{a}$

The quadratic equation whose roots are α and β is $(x - \alpha)(x - \beta)=0$

i.e., $x^2 - (\alpha + \beta)x + \alpha\beta = 0$

i.e.,$x^2 - Sx+P=0$ where S=Sum of the roots and P =Product of the roots.

15. Numbers

Let N be a composite number such that $N = a^p . b^q . c^r \ldots$ where a,b, c are prime factors of N and p, q, r are positive integers.

The number of factors of a number N is given by the expression :

$$(p + 1)(q + 1)(r + 1) \ldots$$

Number of ways of expressing N as a product of two factors is given by :

$$1/2\{(p + 1)(q + 1)(r + 1) \ldots\}$$

If N is a perfect square, then the number of ways of expressing it as a product of two factors is given by following two rules:

(a) as a product of two DIFFERENT factors: $1/2 \{(p+1)(q+1)(r+1)\ldots-1\}$ ways(excluding $\sqrt{N} \times \sqrt{N}$).

(b) as a product of two factors (including $\sqrt{N} \times \sqrt{N}$):

$$1/2\{(p + 1)(q + 1)(r + 1) \ldots + 1\} \text{ ways.}$$

Sum of all the factors of N including 1 and the number itself is given by:

$$\frac{(a^{p+1}-1)}{a-1}\left(\frac{b^{q+1}-1}{}\right)\left(\frac{c^{r+1}-1}{}\right)\ldots$$

Numberofwaysofwriting N asa productoftwoco-primesis 2^{n-1} wherenis the number of distinct prime factors of the given number N.

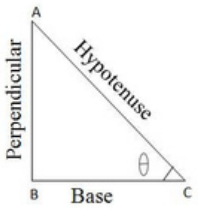
Number of co-primes to N that are less than N is represented by φ(N) given by:

$$\varphi(N) = N\left(1-\frac{1}{a}\right)\left(1-\frac{1}{b}\right)\left(1-\frac{1}{c}\right)\ldots$$

Sum of co-primes to N that are less than N is $\frac{N}{2}\varphi(N)$.

16. Trigonometry

Consider the right angle triangle 4AB C :



$\sin\theta = \frac{\text{Perpendicular}}{\text{Hypotenuse}} = \frac{AB}{AC}$

$\cos\theta = \frac{\text{Base}}{\text{Hypotenuse}} = \frac{BC}{AC}$

$\tan\theta = \frac{\text{Perpendicular}}{\text{Base}} = \frac{BC}{AB}$

$\text{cosec}\,\theta = \frac{1}{\sin\theta}$

$\sec\theta = \frac{1}{\cos\theta}$

$\cot\theta = \frac{1}{\tan\theta}$

θ	sinθ	cosθ	tanθ	cosec θ	secθ	cotθ
0°	0	1	0	∞	1	∞
30°	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$	2	$\frac{2}{\sqrt{3}}$	$\sqrt{3}$
45°	$\frac{1}{\sqrt{2}}$	$\frac{1}{\sqrt{2}}$	1	$\sqrt{2}$	$\sqrt{2}$	1
60°	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$	$\frac{2}{\sqrt{3}}$	2	$\frac{1}{\sqrt{3}}$
90°	1	0	∞	1	∞	0

Standard Identities: $\sin^2\theta + \cos^2\theta = 1$

$1 + \tan^2\theta = \sec^2\theta$

$1 + \cot^2\theta = \operatorname{cosec}^2\theta$

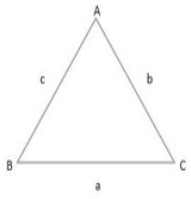
Addition and subtraction formulae:

$\sin(x + y) = \sin x\cos y + \cos x\sin y$ $\quad\quad$ $\sin(x - y) = \sin x\cos y - \cos x\sin y$

$\cos(x + y) = \cos x\cos y - \sin x\sin y$ $\quad\quad$ $\cos(x - y) = \cos x\cos y + \sin x\sin y$

$\tan(x + y) = \frac{\tan x+\tan y}{1-\tan x\tan y}$ $\quad\quad$ $\tan(x - y) = \frac{\tan x - \tan y}{1+\tan x\tan y}$

Sine rule and Co-sine rule:



Sine Rule:

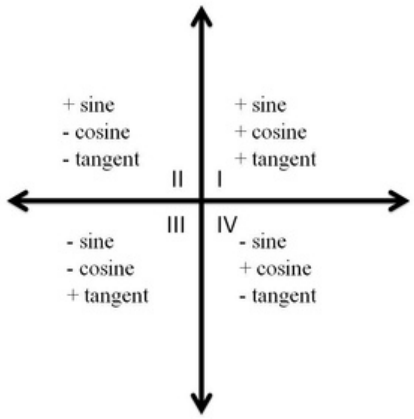
$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$

Cosine-rule:

$$\text{Cos}A = \frac{b^2 + c^2 - a^2}{2bc}$$

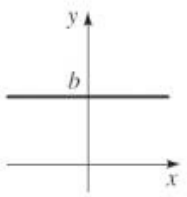
$$\text{Cos}B = \frac{a^2 + c^2 - b^2}{2ac}$$

$$\text{Cos}C = \frac{a^2 + b^2 - c^2}{2ab}$$

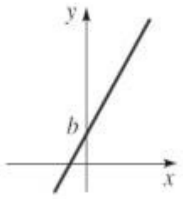


17. Graphs of some standard functions

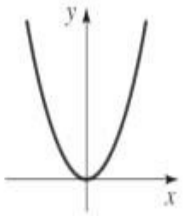
Constant function: f (x) = b



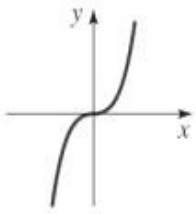
Linear function: f(x) = mx + b



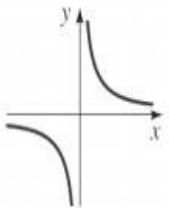
Power function: f (x)=x2



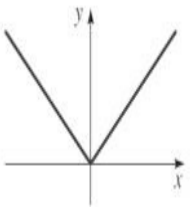
Power function: f (x)=x3



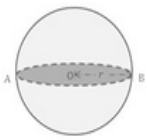
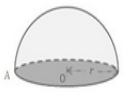
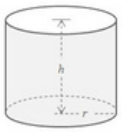
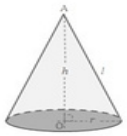
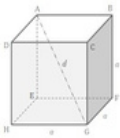
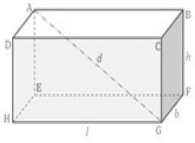
Reciprocal function: $f(x) = \frac{1}{x}$

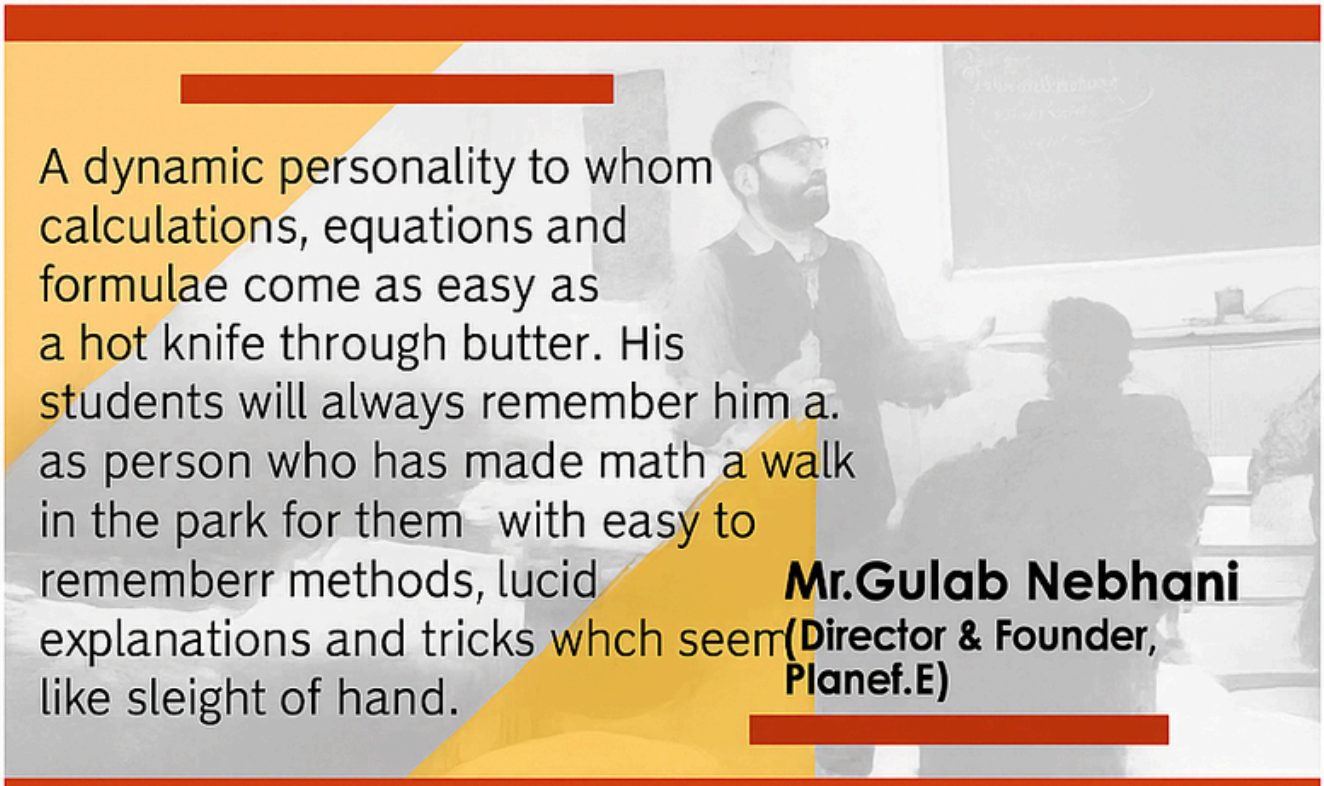


Modulus function: f (x) = |x|



18. Mensuration Formulae

Geometric Object	Volume	Total Surface Area	Curved/Lateral Surface Area
 Sphere	$\frac{4}{3}\pi r3$	$4\pi r2$	$4\pi r2$
 Hemisphere	$\frac{2}{3}\pi r3$	$3\pi r2$	$2\pi r2$
 Cylinder	$\pi r2h$	$2\pi r(+h)$	$2\pi rh$
 Cone	$\frac{1}{3}\pi r2h$	$\pi r(+l)$	πrl
 Cube	a^3	$6a^2$	$4a^2$
 Cub oid	lbh	$2(lb+ bh+ lh)$	$2(lh + bh)$



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Mr.Gulab Nebhani
(Director & Founder, Planef.E)

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