Indices

(1) $a^m \times a^n = a^{m+n}$
eg. 10^3 x $10^2 = 10^{3+2} = 10^5$

(2) $a^m \div a^n = a^{m-n}$; $m > n$, $a \neq 0$
eg. $8^4 \div 8^2 = 8^{4-2} = 8^2$

(3) $(a^m)^n = a^{m \times n}$
eg. $(6^4)^2 = 6^{4\times 2}$

(4) $(a \times b)^m = a^m \times b^m$
eg. $(5 \times 3)^6 = 5^6 \times 3^6$

(5) $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^n}$; $b \neq 0$
eg. $\left(\frac{5}{4}\right)^8 = \frac{5^8}{4^8}$

(6) $a^0 = 1$ $eg. 7^0 = 1$

(7) $a^{-m} = \frac{1}{a^m}$ $eg. 5^{-3} = \frac{1}{5^3}$

Area of Triangle

To find the area of triangle, given the base and height
$= \frac{1}{2} \times Base \times Height$

To find the area of triangle when the length of all its three sides are given

Area of a triangle $= \sqrt{s(s-a)(s-b)(s-c)}$
In the above formula a, b, c are the sides of a triangle and s is the semi-perimeter of triangle. $s = \frac{1}{2}(a+b+c)$

Identities-Expansion, Factors

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

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

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

(4) $(x+a)(x+b) = (x+a) \times x + (x+a) \times b$
$= x^2 + ax + bx + ab$
$= x^2 + (a+b)x + ab$

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

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

(7) $(a^3 + b^3) = (a+b)\left(a^2 - ab + b^2\right)$

(8) $(a^3 - b^3) = (a-b)\left(a^2 + ab + b^2\right)$

Arc of a Circle

Circumference of the circle

(1) C = $2\pi r$ *i.e* $2 \times \pi \times r$
Formula (1) is used to find the circumference when radius is known
(2) C = πd *i.e* $\pi \times d$
Formula (2) is used find the circumference when diameter is known
In the above formulas value of π can be taken as $\frac{22}{7}$, if it's not given

Length of an Arc

Length of an arc $= \frac{\theta}{360} \times 2\pi r$
θ is the angular measure and r is the radius of the circle

Area of a Circle

Area of a Circle $= \pi \times r^2$ *i.e* $\pi \times r \times r$
Here r is the radius of the circle

Area of the sector of circle

Area of the sector of circle $= \frac{\theta}{360} \times \pi r^2$
Here θ is the angular measure of the arc and r is the radius

Compound Interest

$I = \frac{P \times N \times R}{100}$
I = Simple Interest
P = Principal
N = Number of years
R = Rate of Interest

$A = P + I$; A is the Amount and it includes Principal and Interest accrued

Amount(A) by compound interest
$= Principal\left(1 + \frac{Rate}{100}\right)^{Period}$
i.e $(A) = P\left(1 + \frac{R}{100}\right)^N$

Volume and Surface Area

Cylinder

Volume of a Cylinder = $\pi r^2 h$ *i.e* $\pi \times r \times r \times h$
Curved Surface area of a cylinder
= $2\pi rh$ *i.e* $2 \times \pi \times r \times h$
Total surface area of a cylinder
= $2\pi r(h+r)$ *i.e* $2 \times \pi \times r \times (h+r)$

In the formula r is the radius of the base of a cylinder and h is the height

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Cone

Volume of the cone = $\frac{1}{3} \times \pi r^2 h$
Curved Surface Area of the cone = πrl
Total Surface Area of the cone = $\pi r\,(l + r)$
In the formula r is radius of the base of the cone and h is the height and l is the slant height
if any two l, r, h are given and you need to find the third one, then you use the formula
$l^2 = h^2 + r^2$

Sphere

Volume of the sphere = $\frac{4}{3} \times \pi r^3$
Surface area of the sphere = $4\pi r^2$
r is the radius of the sphere

Sets

Complement of set

1) For a set A if A′ is it's complement then (A′)′ = A
2) If U is an universal set and U′ is its complement then U′= ϕ
3) if ϕ denotes and empty set then ϕ' = U
where ϕ' is complement of ϕ

Properties of union of sets

Here A and B are two subsets of universal set U then
1) A ∪ B = B ∪ A
2) If A ⊆ B then A ∪ B = B
3) If A ⊆ A ∪ B
4) A ∪ A′ = U
5) A ∪ A = A
6) A ∪ ϕ = A

Properties of intersection of sets

1) A ∩ B = B ∩ A
2) If A ⊆ B then A ∩ B = A
3) A ∩ B ⊆ A and A ∩ B ⊆ B
4) A ∩ A′ = ϕ 5) A ∩ A = A 6) A ∩ ϕ = ϕ

Number of elements in a set

Number of element in the set A is denoted by n(A) we have
n(A ∪ B) = n(A) + n(B) - n(A ∩ B)
if set A and B are disjoints then n(A ∩ B) = 0 and we have
n(A ∪ B) = n(A) + n(B)

Real Numbers

If a number is of the form $\frac{p}{q}$ where p and q are integers and denominator q ≠ 0, then the number is called a rational number
Set of all rational numbers is denoted by the letter Q and

$$\therefore \quad Q = \left\{ \frac{p}{q} \quad | \, p, q \in I \text{ and } q \neq 0 \right\}$$

Equality relation: $\frac{p}{q}$ and $\frac{r}{s}$ are any two rational numbers and
if $\frac{p}{q} = \frac{r}{s}$, **then** ps=qr and conversely **if** ps=qr **then** $\frac{p}{q} = \frac{r}{s}$

Order relation: $\frac{p}{q}$ and $\frac{r}{s}$ are any two rational numbers with both denominators q> 0 and s > 0 then
if $\frac{p}{q} > \frac{r}{s}$, **then** $ps > qr$ and conversely **if** $ps > qr$ **then** $\frac{p}{q} > \frac{r}{s}$

Properties of rational number

if a, b, c are any rational numbers then

$a + b = b + a$	Commutative property
$(a + b) + c = a + (b + c)$	Associative property
$a + 0 = 0 + a = a$	Additive identity
$a + (-a) = (-a) + a = 0$	Additive inverse
$a \times b = b \times a$	Commutative property
$(a \times b) \times c = a \times (b \times c)$	Associative property
$a \times 1 = 1 \times a = a$	Multiplicative identity
$a \times \frac{1}{a} = \frac{1}{a} \times a = 1$	Multiplicative inverse
$a \times (b + c) = a \times b + a \times c$	Distributive property

Properties of real number

1) If a and b are any two real numbers, then only one of the following relation is true
(i) $a = b$ (ii) $a < b$ (iii) $a > b$
2) If $a < b$ and $b < c$ then $a < c$
3) If $a < b$ then $a + c < b + c$
4) Let $a < b$ then
(i) If $c > 0$ then $ac < bc$ (ii) If $c < 0$ then $ac > bc$

If x is a real number absolute value of x is denoted by $|x|$ and is define as
$|x| = x$ for $x > 0$
$= 0$ for $x = 0$
$= -x$ for $x < 0$ and if $|x| = a$ then $x = \pm\, a$

Surds

A number of the form $\sqrt[n]{a}$ is said to be a surd if
✓ n is a natural number and $n \neq 1$
✓ a is a positive rational number
✓ $\sqrt[n]{a}$ is an irrational number

Laws of Surd
1) $\left(\sqrt[n]{a}\right)^n = a$ $e.g$ $\left(\sqrt[4]{10}\right)^4 = 10$
2) $\sqrt[n]{a}.\sqrt[n]{b} = \sqrt[n]{ab}$ $e.g$ $\sqrt[3]{20}.\sqrt[3]{4} = \sqrt[3]{80}$
3) $\frac{\sqrt[n]{a}}{\sqrt[n]{b}} = \sqrt[n]{\frac{a}{b}}$ $e.g$ $\frac{\sqrt[7]{10}}{\sqrt[7]{19}} = \sqrt[7]{\frac{10}{19}}$
4) $\sqrt[m]{\sqrt[n]{a}} = \sqrt[mn]{a} = \sqrt[n]{\sqrt[m]{a}}$ $e.g \sqrt[3]{\sqrt[5]{72}} = \sqrt[15]{72} = \sqrt[5]{\sqrt[3]{72}}$

Forms of Surd
1) Pure surds : A surd of the form $\sqrt[n]{a}$ is called a pure surd
e.g $\sqrt[3]{19}$ is pure surd
2) Mixed surds : A surd of the form $m \times \sqrt[n]{a}$ *where* m (± 1) is a rational number, is called a mixed surd
e.g $8\sqrt[3]{27}$ is mixed surd
3) Similar Surd
⇒ The surds of the form $p\sqrt[n]{a}$ and $q\sqrt[n]{a}$, where p and q are rational numbers are called similar surds
e.g $\sqrt{4}$, $\sqrt[3]{4}$, $\frac{7}{8}\sqrt{4}$ are similar surds

Simplest form of a surd
A Surd $\sqrt[n]{a}$ is said to be in its simplest form if
✓The radicand a has no factor which is n^{th} power of a rational number
✓The radicand a is not fraction
✓n is the least order

Comparison of surds
Suppose $\sqrt[n]{a}$ and $\sqrt[n]{b}$ are two surds of same order(n) then they can be compared by comparing there radicand (a, b in the e.g)
i) $\sqrt[n]{a} = \sqrt[n]{b}$ if $a = b$
ii) $\sqrt[n]{a} > \sqrt[n]{b}$ if $a > b$
iii) $\sqrt[n]{a} < \sqrt[n]{b}$ if $a < b$
Rationalization of surds: If we multiply two surds and the product we get is a rational number, then we say each surd is a rationalizing factor of the other surd

Factorization of algebraic expression

Factorization of an algebraic expression of the form
$a^3 + b^3 + c^3 - 3abc$
$= (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ca)$
(i) If $a + b + c = 0$ then $a^3 + b^3 + c^3 = 3abc$
(ii) If $a + b + c \neq 0$and$a^3 + b^3 + c^3 - 3abc = 0$then$a = b = c$

Polynomials

An algebraic expression is called a polynomial if
✓It's of the form $a_0 + a_1x + a_2x^2 + \cdots + a_{n-1}x^{n-1} + a_nx^n$
✓$a_0, a_1, a_2 \cdots a_{n-1}, a_n$ are real numbers
✓n is a non-negative integer
a polynomial in x is denoted by $p(x)$,
If we arrange terms of polynomial such that power of x are in ascending or are in descending order, then we say polynomial is in the **standard form**
Degree of a polynomial: Suppose a polynomial is in x, then the highest power(index) of x is called the degree of the polynomial

Types of Polynomial

Monomial	One term	e.g $3, 10x, 12x^3$
Binomial	Two terms	e.g $4x + 12x^3$
Trinomial	Three terms	e.g $3 + 10x + 4x^2$

Zero polynomial: If all coefficient of a polynomial are zero it's called a zero polynomial
e.g $0 + 0x, 0x + 0x^3$

Constant polynomial: if a polynomial $p(x) = a_0 + a_1x + a_2x^2 + \ldots + a_{n-1}x^{n-1} + a_nx^n$ is such that $a_1 = a_2 = a_3 = \ldots a_{n-1} = a_n = 0$ then $P(x)$ is called constant polynomial i.e $p(x) = a_0 + 0 + 0 + 0 \ldots = a_0$
$p(x) = 12, p(x) = -2$ are examples constant polynomial

Ratio and proportion

Properties of ratio
1)$ma : mb = a : b = \frac{a}{m} : \frac{b}{m}$
2) if $a : b$ and $c : d$ are the two given ratio then
⇒ if $a \times d = b \times c$ then $a : b = c : d$
⇒ if $a \times d > b \times c$ then $a : b > c : d$
⇒ if $a \times d < b \times c$ then $a : b < c : d$

Properties of equal ratios
⇒ if $\frac{a}{b} = \frac{c}{d}$ then $\frac{b}{a} = \frac{d}{c}$ → Invertendo
⇒ if $\frac{a}{b} = \frac{c}{d}$ then $\frac{a}{c} = \frac{b}{d}$ → Alternedo
⇒ if $\frac{a}{b} = \frac{c}{d}$ then $\frac{a+b}{b} = \frac{c+d}{d}$ → Componendo
⇒ if $\frac{a}{b} = \frac{c}{d}$ then $\frac{a-b}{b} = \frac{c-d}{d}$ → Dividendo
⇒ if $\frac{a}{b} = \frac{c}{d}$ then $\frac{a+b}{a-b} = \frac{c+d}{c-d}$ → Componendo-Divedendo

Theorem on equal ratios: if $\frac{a}{b} = \frac{c}{d} = \frac{e}{f}$ then
✓ $\frac{a}{b} = \frac{a+c+e}{b+d+f}$
✓ $\frac{c}{d} = \frac{a+c+e}{b+d+f}$
✓ $\frac{e}{f} = \frac{a+c+e}{b+d+f}$
i.e each ratio $= \frac{a+c+e}{b+d+f}$

Proportion: if $\frac{a}{b} = \frac{c}{d}$ then a, b, c, d are said to be in proportion
if $\frac{a}{b} = \frac{c}{d}$ then $a \times d = b \times c$
Continued proportion: if $\frac{a}{b} = \frac{b}{c}$ then a, b, c are said to be in continued proportion
we have if a, b, c are in continued proportion then
$\frac{a}{b} = \frac{b}{c}$ i.e $b^2 = \frac{a}{c}$
$\therefore$ $b = \sqrt{ac}$ b is called geometric mean or mean proportional to a and c

Statistic

Mean
Mean of raw data : If $x_1, x_2, \ldots x_n$ are given observations all are numbers then we defined their mean as $\bar{x}$, and $\bar{x} = \frac{x_1+x_2+x_n}{n}$
Mean of ungrouped data
$\bar{x} = \frac{f_1x_1 + f_2x_2 \ldots + f_nx_n}{f_1 + f_2 \ldots + f_n}$ *i.e* $\bar{x} = \frac{1}{N}\sum f_ix_i$ where $N = \sum f_i$
Here, $x_1, x_2, \ldots x_n$ are observations and $f_1, f_2, f_3 \ldots f_n$ are frequencies
Median
Suppose N is is the number of observation made, and they are arranged in either ascending or in descending order of magnitudes then

1. If N is Odd then Median = $\left(\frac{N+1}{2}\right)^{\text{th}}$ term
2. if N is Even then Median
   = A.M of $\left(\frac{N}{2}\right)^{\text{th}}$and $\left(\frac{N+1}{2}\right)^{\text{th}}$ terms

Mode:The observation(s) which has a maximum number of frequency is called a mode

Percentage profit & loss

1) Profit = S.P - C.P
2) Loss = C.P - S.P

3) Profit percentage = $\frac{Pprofit}{C.P} \times 100$

4) Loss percentage =$\frac{Loss}{C.P} \times 100$

Discount Rebate & Commission

1. Discount = printed price × rate of discount
2. Selling price = printed price - discount
3. Percentage of discount =$\frac{\text{discount}}{\text{printed price}} \times 100$

Trigonometry

Trigonometric ratios of an acute angle

Sin θ	$\frac{\text{Opposite side of angle } \theta}{\text{Hypotenusee}}$
Cos θ	$\frac{\text{Adjacent side of angle } \theta}{\text{Hypotenusee}}$
Tan θ	$\frac{\text{Opposite side of angle } \theta}{\text{Adjacent side of angle } \theta}$
Cosec θ	$\frac{\text{Hypotenuse}}{\text{Opposite side of angle } \theta}$
Sec θ	$\frac{\text{Hypotenuse}}{\text{Adjacent side of angle } \theta}$
Cot θ	$\frac{\text{Adjacent side of angle } \theta}{\text{Opposite side of angle } \theta}$

Relationship between the trigonometric ratios

sinAcosecA=1	sinA=$\frac{1}{\text{cosecA}}$	cosecA=$\frac{1}{\text{sinA}}$
cosAsecA=1	secA=$\frac{1}{\text{cosA}}$	cosA=$\frac{1}{\text{secA}}$
tanAcotA=1	tanA=$\frac{1}{\text{cotA}}$	cotA=$\frac{1}{\text{tanA}}$
tanA=$\frac{\text{sinA}}{\text{cosA}}$	cotA=$\frac{\text{cosA}}{\text{sinA}}$	

Ratios of angle

M. of $\angle^s \rightarrow$ $\downarrow$ Ratios of $\angle^s$	0°	30°	45°	60°	90°
$\sin\theta$	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1
$\cos\theta$	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0
$\tan\theta$	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	ND
cosec θ	ND	2	$\sqrt{2}$	$\frac{2}{\sqrt{3}}$	1
$\sec\theta$	1	$\frac{2}{\sqrt{3}}$	$\sqrt{2}$	2	ND
$\cot\theta$	ND	$\sqrt{3}$	1	$\frac{1}{\sqrt{3}}$	0

Perimeters(P) and Areas(A) of some plane fig's

1. Triangle: a, b, c are sides of $\triangle$, h is the ht
   (a) Perimeter = $a + b + c$
   (b) Area =$\frac{1}{2} \times base \times height$
   (c) By Heron's formula
   Area=$\sqrt{(s-a)(s-b)(s-c)}$
   here s=$\frac{a+b+c}{2}$
2. Equilateral $\triangle$: Each side=a
   (a) Perimeter = $a + a + a = 3a$
   (b) Area =$\frac{\sqrt{3}}{4} \times a^2$
3. Square: Each side=a
   (a) Perimeter = $a + a + a + a = 4a$
   (b) Area = $a \times a = a^2$
4. Rectangle: l is length & b is breadth
   (a) Perimeter = $2 \times (l + b)$
   (b) Area=length × breadth i.e $l \times b$
5. Parallelogram:a,b are sides of $||^m$ and h is ht.
   (a) Perimeter = $2 \times (a + b)$
   (b) Area=base × height i.e $b \times h$
6. Trapezium: a, b, c, d are sides, h is height, here sides a & b are opp. $||$ sides
   (a) Perimeter = $a + b + c + d$
   (b) Area=$\frac{1}{2}$×(sum of the lengths of $||$ sides)×(height)
   $= \frac{1}{2}(a + b) \times h$
7. Rhombus: l is the measure of all sides and d_1, d_2 are the diagonals.
   (a) Perimeter = $4 \times l$
   (b) Area=$\frac{1}{2}$×(products of the diagonals)
   $= \frac{1}{2}(d_1 \times d_2)$
8. circle:r is the radius.
   (a) Perimeter = Circumference = $2\pi r$
   (b) Area = πr^2