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1 NUMBER SYSTEM

FACTORS AND MULTIPLES

1. Number of Factors (divisors):

If ‘N’ is a composite number such that **‘N’**

= $a^x \times b^y \times c^z \times \ldots$

Here, ‘a’, ‘b’ and ‘c’ are prime numbers and ‘x’, ‘y’ and ‘z’ are natural numbers.

- Number of factors of ‘N’ **= (x + 1) × (y + 1) × (z + 1) × …**
- Sum of Factors of ‘N’ **=** $(a^0 + a^1 + a^2 \ldots + a^x) \times (b^0 + b^1 + b^2 \ldots + b^y) \times (c^0 + c^1 + c^2 \ldots + c^z) \times \ldots$
- Product of Factors of ‘N’ = $N^{\left(\frac{\text{Number of factors}}{2}\right)}$
- Number of prime factors of ‘N’ = a, b, c, …

2. Even and Odd factors of a number:

If N = $2^x \times b^y \times c^z \times \ldots$

- **If ‘N’ is even, then x > 0 but if ‘N’ is odd, then x = 0**

- Total number of even factors **= x × (y + 1) × (z + 1) × ...**
- Sum of even factors **=** $(2^1 + 2^2 \ldots + 2^x) \times (b^0 + b^1 + b^2 \ldots + b^y) \times (c^0 + c^1 + c^2 \ldots + c^z) \times \ldots$
- Total number of odd factors **= (y + 1) × (z + 1) × …**
- Sum of odd factors **=** $(b^0 + b^1 + b^2 \ldots + b^y) \times (c^0 + c^1 + c^2 \ldots + c^z) \times \ldots$

Also, total number of factors = Number of a even factors + Number of odd factors

DIVISIBILITY

Divisibility by ‘2’ : If the unit's digit of a number is 0, 2, 4, 6 or 8.

Divisibility by ‘3’ : If the sum of the digits of a number is divisible by 3.

Divisibility by ‘4’ : If the last 2 digits of a number is divisible by 4 or the last 2 digits of a number is zero.

Divisibility by ‘5’ : If the last digit of a number is either 0 or 5.

Divisibility by ‘6’ : If the number is divisible by 2 and 3 both.

Divisibility by ‘7’ : If the difference between twice the last digit and the number formed by the remaining digits is either zero or a multiple of 7.

Divisibility by ‘8’ : If the last three digits of a number is divisible by 8 or the last three digits of a number is zero.

Divisibility by ‘9’ : If the sum of the digits of a number is divisible by 9.

Divisibility by ‘11’ : If the difference between the sum of its digits at odd places and the sum of its digits at even places is either 0 or a multiple of 11.

Divisibility by ‘12’ : If the number is divisible by 3 as well as 4.

Note:

- A four digit number of the form ‘abab’ will always be divisible by ‘101’
- A six digit number of the form ‘ababab’ will always be divisible by ‘3’, ‘7’, ‘13’ and ‘37’
- A number of the form ‘aaa’ will always be divisible by ‘3’ and ‘37’
- A six digit number of the form ‘aaaaaa’ will always be divisible by ‘3’, ‘7’, ‘13’ and ‘37’
- A six digit number of the form ‘abcabc’ will always be divisible by ‘3’, ‘7’ and ‘11’.

CYCLICITY AND UNIT DIGIT

The unit’s digit of an expression can be calculated by getting the remainder when the expression is divided by 10. Thus, unit digit of $(\ldots\ldots\ldots\ldots \boldsymbol{ABCD})^x$ will depend upon the unit digit of $\boldsymbol{D^x}$.

Different values of 'D'	If the values of 'x' is [4n + 1]	If the values of 'x' is [4n + 2]	If the values of 'x' is [4n + 3]	If the values of 'x' is [4n + 4]
0	0	0	0	0
1	1	1	1	1
5	5	5	5	5
6	6	6	6	6
4	4	6	4	6
9	9	1	9	1
2	2	4	8	6
3	3	9	7	1
7	7	9	3	1
8	8	4	2	6

REMAINDER

1. Remainder of $\left(\frac{a \pm b}{n}\right)$

   = Remainder of $\left(\frac{a}{n}\right)$ ± Remainder of $\left(\frac{b}{n}\right)$

   If after addition, the result is more than 'n', then it will be further divided by 'n' and the resulting remainder will be our answer.

2. Remainder of $\left(\frac{a \times b}{n}\right)$

   = Remainder of $\left(\frac{a}{n}\right)$ × Remainder of $\left(\frac{b}{n}\right)$

   If after multiplication, the result is more than 'n', then it will be further divided by 'n' and the resulting remainder will be our answer.

3. If an expression can be written in the form $\frac{(ax+1)^n}{a}$, then the remainder of the given expression will always be 1.
4. If an expression can be written in the form $\frac{(ax-1)^n}{a}$, then the remainder of the given expression will be:
   - '-1' or (a – 1) if 'n' is odd.
   - '1' if 'n' is even.
5. If an expression can be written in the form of $\frac{(a)^n}{a+1}$, then the remainder will be:
   - 'a' if 'n' is odd.
   - '1' if 'n' is even.
6. **Fermat's Theorem:**

   If an expression can be expressed as $\frac{a^{(P-1)}}{P}$ such that 'P' is a prime number and 'a' & 'P' are co-prime to each other, then the remainder of the given expression will always be '1'.
7. If an expression is given as $\frac{a^n}{b}$, then the remainder of the following expression will be (remainder obtained when 'a' prime is divided by 'b')^n.
8. The square of any odd number when divided by 8 will leave 1 as the remainder.

NUMBER OF ZEROS

Number of zeros in a given expression depends on the number of pairs of 2's and 5's available in the expression. If in a given expression

- Number of 2's < Number of 5's, then number of zeros in the expression = Number of 2's
- Number of 5's < Number of 2's, then number of zeros in the expression = Number of 5's

Note:
If the expression contains 10 (= 2 × 5) it means the expression will have as many additional zeros at the 10 as the number of 10's in the expression.

Process to find the number of zeros at the end of 'n!':

Since, n! = n × (n - 1) × (n - 2) × ....× 1

Number of zeros = power of '5'

In the case of factorial, the power of '5' is a limiting factor as '5' is less likely to occur than '2'.

Maximum power of '5' in 'n!'

$= \frac{n}{5} + \frac{n}{5^2} + \frac{n}{5^3} + \ldots$

[Consider the integral part only]

	Sum of 'n' consecutive numbers	Sum of squares	Sum of cubes
Natural Numbers	$\frac{n(n+1)}{2}$	$\frac{n(n+1)(2n+1)}{6}$	$\left[\frac{n(n+1)}{2}\right]^2$
Even Numbers	$n(n+1)$	$\frac{2n(n+1)(2n+1)}{3}$	$2\{n(n+1)\}^2$
Odd Numbers	n^2	$\frac{n(2n+1)(2n-1)}{3}$	$n^2(2n^2-1)$

2 LCM & HCF

L.C.M.

1. LCM of Fractions:

Express the given fraction in their lowest terms.

L.C.M of given fractions $= \frac{L.C.M. of\ numerators}{H.C.F\ of\ denominators}$

2. Applications of LCM:

- The smallest number which is exactly divisible by 'x', 'y' and 'z' = L.C.M of x, y, z.
- The L.C.M of two or more numbers is greater than or equal to the greatest number of given numbers.
- The number which when divided by 'x', 'y' and 'z' leaves a remainder 'R' in each case. Then, the required number = (L.C.M of x, y, z) × K + R, where K is a constant
- The smallest number which when divided by 'x', 'y' and 'z' leaves the remainder of 'a', 'b', 'c' such that common difference(d) = x - a = y – b = z – c. Then the required number = (L.C.M of x, y and z) × K – d, where K is a constant
- If some bells ring after an interval of 'a' seconds, 'b' seconds and 'c' seconds, respectively, then together they will ring after LCM of (a, b and c) seconds. Number of times they will ring together in 'T' seconds= $\frac{T}{LCM\ of\ (a,b\ and\ c)} + 1$ (if they start ringing together initially)

H.C.F.

1. H.C.F. of Fractions:

Express the given fractionin their lowest terms.

H.C.F of fractions $= \frac{H.C.F. of\ numerators}{L.C.M. of\ denominators}$

2. Applications of HCF:

- The H.C.F of two or more numbers is smaller than or equal to the smallest number of given numbers.
- Let 'K' be the largest number which when divide a,b,c gives the same remainder 'r' & quotients are x, y, z respectively then,

  K = HCF of (a – b, b – c, c – a).
- The greatest number which divides x, y and z to leave the remainder R is

  H.C.F of (x – R), (y – R) and (z – R).
- The greatest number which divides x, y, z to leave remainders a, b, c is

  H.C.F of (x – a), (y – b) and (z – c).

PRODUCT RULE

If 'p' and 'q' are two numbers then,

Product of numbers (p × q)

= (H.C.F. of 'p' and 'q') × (L.C.M. of 'p' and 'q')

3 SURDS & INDICES

LAWS OF SURDS

1. $\sqrt[n]{a} = a^{\frac{1}{n}}$
2. $\sqrt[m]{ab} = \sqrt[m]{a} \times \sqrt[m]{b} = a^{\frac{1}{m}} \times b^{\frac{1}{m}} = (ab)^{\frac{1}{m}}$
3. $\sqrt[m]{\frac{a}{b}} = \frac{\sqrt[m]{a}}{\sqrt[m]{b}} = \left(\frac{a}{b}\right)^{\frac{1}{m}}$
4. $(\sqrt[n]{a})^m = a^{\frac{m}{n}} = \sqrt[n]{a^m}$
5. $\sqrt[m]{\sqrt[n]{a}} = \sqrt[m]{a^{\frac{1}{n}}} = a^{\frac{1}{mn}}$

LAWS OF INDICES

1. $n^a \times n^b = n^{(a+b)}$
2. $\frac{n^a}{n^b} = n^{(a-b)}$
3. $(n^a)^b = n^{ab}$
4. $(ab)^m = a^m \times b^m$
5. $n^0 = 1$

4 ELEMENTARY ALGEBRA

SOME IMPORTANT IDENTITIES

1.	$(a + b)^2 = a^2 + 2ab + b^2$
2.	$(a - b)^2 = a^2 - 2ab + b^2$
3.	$a^2 - b^2 = (a + b)(a - b)$
4.	$(a + b)^3 = a^3 + b^3 + 3ab\,(a + b)$
5.	$(a - b)^3 = a^3 - b^3 - 3ab\,(a - b)$
6.	$(a + b + c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$

$If\ x + \frac{1}{x} = A$	$x^2 + \frac{1}{x^2} = A^2 - 2$	$x^3 + \frac{1}{x^3} = A^3 - 3A$
$If\ x - \frac{1}{x} = A$	$x^2 + \frac{1}{x^2} = A^2 + 2$	$x^3 - \frac{1}{x^3} = A^3 + 3A$

QUADRATIC EQUATIONS

Sum of roots and Product of roots:

Let α, β are real roots of the quadratic equation $ax^2 + bx + c = 0$

Since, $ax^2 + bx + c = 0$

Dividing each term br 'a', we get;

$x^2 + \left(\frac{b}{a}\right)x + \left(\frac{c}{a}\right) = 0$ ...eq(1)

So, sum of roots $= \boldsymbol{\alpha} + \boldsymbol{\beta} = -\frac{\boldsymbol{b}}{\boldsymbol{a}}$

And, product of roots $= \boldsymbol{\alpha} \times \boldsymbol{\beta} = \frac{\boldsymbol{c}}{\boldsymbol{a}}$

5 AVERAGE

Average or Mean = $\frac{\textit{Sum of all observations}}{\textit{Number of observations}}$

Facts about Average

- When each of the observations is increased/decreased by 'p', then the overall average will also increase/decrease by 'p'.
- When each observation is multiplied/ divided by 'p', then the overall average will also get multiplied/divided by 'p'.

  If the average of 'a' numbers is 'x' and out of these 'a' numbers average of 'b' numbers is 'y', then average of remaining numbers will be:

$$\frac{ax - by}{a - b}$$

Application of average:

When a person leaves a group and is replaced by another person, then

Case-I: Increase in average	Age/weight/height of new person = Age/weight/height of person who left the group + (Number of persons in the group including new person × Increase in average age/weight/height of the group)
Case-II: Decrease in average	Age/weight/height of new person = Age/weight/height of person who left the group – (Number of persons in the group including new person × Decrease in average age/weight/height of the group)

When a person leaves the group but nobody joins that group, then

Case I: Increase in average	Age/Weight/Height etc of person left = Previous average (Number of persons present × Increase in average)
Case II: Decrease in average	Age/Weight/Height etc of person left = Previous average + (Number of persons present x Decrease in average)

- If the average of 'M' number of observations is 'N' but some observations are misread as 'a', 'b' and 'c' in place of 'x', 'y' and 'z', respectively, then the correct average = $\frac{M \times N - (a+b+c) + (x+y+z)}{M}$

6 PERCENTAGE

PERCENTAGE INCREASE / DECREASE OF A QUANTITY

- If an amount is increased by x% and then it is decreased by x% again, then there is always an overall percentage decrease which is equal to:

Percentage Decrease = $\frac{x^2}{100}$ %

- If an amount is increased by x% and then it is increased by y% again, then the resultant change in percentage is

Percentage change = $\left(x + y + \frac{xy}{100}\right)$ %

INCOME / EXPENDITURE PROBLEMS:

- If the income of a person 'A' is 'x%' more than person 'B', then income of 'B' is less in comparison to 'A' by $\left(\frac{x}{100+x} \times 100\right)$%
- If the income of a person 'A' is 'x%' less than person 'B', then income of 'B' is more in comparison to 'A' by $\left(\frac{x}{100-x} \times 100\right)$%

POPULATION / PRICE / QUANTITY RELATED PROBLEMS

If the present population of a town is 'P' and the population increases or decreases at rate of 'x%', 'y%' and 'z%' in the first, second and third year, respectively.

- Then the population of town after 3 years $= P\left(1 \pm \frac{x}{100}\right)\left(1 \pm \frac{y}{100}\right)\left(1 \pm \frac{z}{100}\right)$
'+' sign indicates increase in population and '–' sign indicates decrease in population.

EXAMINATION MARKS RELATED PROBLEMS

In a certain examination, 'x' boys and 'y' girls participated, out of which 'a%' of boys and 'b%' of girls passed the examination, then, percentage of passed students of the total students = $\left(\frac{x \times a + y \times b}{x + y}\right)$ %

GEOMETRICAL FIGURES RELATED PROBLEMS

- If the sides of an equilateral triangle, square, rhombus or radius of a circle are increased by a%, then its area is increased by

$$= \left(2a + \frac{a^2}{100}\right)\%$$

- If the sides of an equilateral triangle, square, rhombus or radius of a circle decreased by a%, then its area is decreased by

$$= \left(-2a + \frac{a^2}{100}\right)\%$$

- If the length of a rectangle is increased by 'x%' and breadth is increased by 'y%', then the area of rectangle will increase by

$$= \left(x + y + \frac{xy}{100}\right)\%$$

7 RATIO, MIXTURE & PROPORTION

CONTINUED PROPORTION

'a', 'b' and 'c' are said to be in continued proportion if a : b = b : c or $b^2 = ac$
Here 'b' is the mean proportional to 'a' and 'c', and 'c' is the third proportional to 'a' and 'b'.
Fourth Proportion: If four quantities 'a', 'b', 'c' and 'x' are such that a:b :: c:x, then 'x' is called the fourth proportion of 'a', 'b' and 'c'.
Also, $x = \frac{bc}{a}$

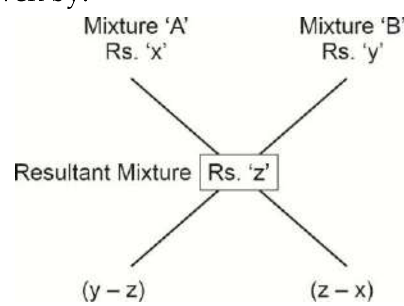
PARTNERSHIP

If two partners entered into a business investing Rs. 'I_1' and Rs. 'I_2' for 't_1' months and 't_2' months such that profit earned by them is Rs. 'P_1' and Rs. 'P_2', then $\frac{P_1}{P_2} = \frac{I_1 \times t_1}{I_2 \times t_2}$

MIXTURE AND ALLIGATION

- 'P' litres of mixture contains 'a%' of liquid 'A'. The quantity of water that must be mixed in the mixture such that the resulting mixture contains 'b%' of liquid 'A'

  $= P \times \frac{a-b}{b}$
- If a milkman mixes 'y' litres of water with 'x' litres of pure milk and promises to sell the milk at cost price, then profit percentage of the milkman = $\frac{y}{x+y} \times 100$
- If mixture 'A' costing Rs. 'x' per kg is mixed with mixture 'B' costing Rs. 'y' per kg and the resultant mixture is sold for Rs. 'z' per kg such that x < z < y, then the ratio in which mixture 'A' and mixture 'B' are mixed can be given by:



$$\frac{\text{Quantity of mixture 'A'}}{\text{Quantity of mixture 'B'}} = \frac{y-z}{z-x}$$

- If a container contains 'P' units of pure liquid (milk/kerosene/wine etc.) and is altered by taking out 'Q' units of the pure liquid and replacing it by same quantity of another liquid and this process is repeated 'n' times, then quantity of pure liquid in the find mixture will be $= P \times \left\{1 - \frac{Q}{100}\right\}^n$

8 PROFIT, LOSS & DISCOUNT

IMPORTANT FORMULAS

(i) In case of Profit; Profit = SP – CP

(ii) Profit percentage = $\frac{profit}{cost\ price} \times 100$ %

(iii) In case of Loss; Loss = CP – SP

(iv) Loss percentage = $\frac{loss}{cost\ price} \times 100$ %

(v) SP = (100 + k)% of CP (k = profit %)

(vi) SP = (100 – k)% of CP (k = loss %)

SOME IMPORTANT RESULT

- If cost price = Selling price, then there will be no profit no loss.
- If the profit earned on selling an article for Rs. 'x' is same as the loss incurred on selling the article for Rs. 'y', then cost price of the article = $\frac{x+y}{2}$
- If two articles are sold at the same price such that profit earned on selling one article is x%

while loss incurred on selling the other article is x% then there will be overall loss of $\frac{x^2}{100}$%.

DISCOUNT

(i) Selling price = Marked price - Discount

(ii) Discount = Marked price - Selling price

(iii) Discount % = $\left(\frac{Discount}{Marked\ price}\right) \times 100$

(iv) Selling price = $\left(\frac{100-r}{100} \times \text{ marked price}\right)$,

where 'r' = discount percentage

When two successive discounts are given:

Suppose two successive discounts of 'r_1%' and 'r_2%' are given on an article, then the selling price of the article after these discounts will be:

$$= \left(1-\frac{r_2}{100}\right) \times \left(1-\frac{r_1}{100}\right) \times P$$

or

Net discount percentage = $\left(r_1 + r_2 - \frac{r_1 r_2}{100}\right)$%

When three successive discounts are given:

Suppose there are three successive discounts of 'r_1%' , 'r_2%' and 'r_3%' is given on an article, then the selling price of the article after these discounts will be:

$$= \left(1-\frac{r_3}{100}\right) \times \left(1-\frac{r_2}{100}\right) \times \left(1-\frac{r_1}{100}\right) \times P$$

DISHONEST SHOPKEEPER

If a shopkeeper promises to sell his goods at cost price but uses a faulty weight of 'x' gm instead of 1 kg or 1000 gm, then overall gain percentage of the shopkeeper

$$= \left(\frac{1000-x}{x} \times 100\right)\%$$

- If a shopkeeper sells his goods at 'x%' profit and uses a weight which is 'y%' less than the actual weight, then overall gain percentage of the shopkeeper

$$= \left\{\frac{x\% + y\%}{100 - y\%} \times 100\right\} \%$$

9 SIMPLE & COMPOUND INTEREST

Simple Interest (SI) = $\frac{P \times R \times T}{100}$
Total Amount = Principal Amount + SI
Compound Interest (CI) = A – P
Total Amount = $A = P \times \left(1 + \frac{R}{100}\right)^T$

Where:

'A' is the future value of the investment.

'P' is the principal amount or initial investment.

'R' is the rate of interest (in per annum).

'T' is the time in years.

When the rate of of compound interest is different for different years:

$$A = P \times \left(1+\frac{R_1}{100}\right) \times \left(1+\frac{R_2}{100}\right) \times \left(1+\frac{R_3}{100}\right) \ldots \times \left(1+\frac{R_n}{100}\right)$$

Here, 'A' is the amount accumulated after 'n' years.

'P' = Principal amount invested

And, $R_1, R_2, \ldots, R_n$ is the rate of interest offered in first year, second year and nth year respectively.

Difference between CI and SI

For the first compounding period (for first year in general), the SI and CI are equal.

- The difference between SI and CI for first two years = $\frac{PR^2}{100^2}$
- The difference between SI and CI for the first three years = $P\left(\frac{R}{100}\right)^2\left(\frac{300+R}{100}\right)$

1. Installment Paid With Simple Interest:

The annual payment that will discharge a debt of Rs. 'P' due in 'T' years at the rate of simple interest of 'R%' per annum is: $x = \frac{100P}{100T + \frac{RT(T-1)}{2}}$

2. Installment Paid With Compound Interest:

To calculate the installments paid with compound interest, we use the following formula: $x = \frac{P}{\left(1+\frac{R}{100}\right) + \left(1+\frac{R}{100}\right)^2 + \ldots + \left(1+\frac{R}{100}\right)^n}$

10 TIME, SPEED & DISTANCE

Distance = Speed × Time,
Time = $\frac{Distance}{speed}$ and **Speed** = $\frac{Distance}{time}$

CONVERSION OF UNITS

- 1 km =1000 metres
- 1 hour = 60 minutes
- 1 minute = 60 seconds
- 1 m/s = $\frac{18}{5}$ km/h

AVERAGE SPEED

Average Speed = $\frac{\textit{Total distance travelled}}{\textit{Total time taken}}$

- If a certain distance is covered at a speed of 'x' km/h and the same distance is covered at a speed of 'y' km/h, then the average speed for the whole journey = $\frac{2xy}{x+y}$ km/h
- If a person or a motor car covers three equal distances at the speed of 'x' km/h, 'y' km/h and 'z' km/h, respectively, then the average speed for the entire journey

$$= \frac{3xyz}{xy + yx + zx}\ km/h$$

- If a person covers 'A' km at a speed of 'x' km/h, 'B' km at a speed of 'y' km/h and 'C' km at a speed of 'z' km/h, then average speed during the whole journey

$$= \frac{A+B+C}{\frac{A}{x}+\frac{B}{y}+\frac{C}{z}}\ km/h$$

RELATIVE MOTION

- **When two bodies are moving in the same direction:** If the speeds of bodies 'A' and 'B' are S_A and S_B, then their relative speed is $(S_A - S_B)$ or $(S_B - S_A)$.
- **When two bodies are moving in the opposite direction:** If the speeds of bodies 'A' and 'B' are $'S_A'$ and $'S_B'$, then their relative speed is $(S_A + S_B)$.

TRAIN PROBLEMS

- If a train of length 'l' metres travelling with a speed of 'x' m/s crosses a pole/man/tree/bus/truck/car in 't' seconds, then it will cover a distance equal to its length i.e. **l = s × t**
- If a train of length 'l' metres travelling with a speed of 's' m/s crosses a 'p' metres long platform/tunnel in 's' seconds, then
  l + p = s × t
- If two trains are travelling on parallel tracks and in the same direction, then time taken by them cross each other

$$= \frac{\textit{Sum of their individual lengths}}{\textit{difference between their speeds}}$$

- If both trains are travelling on parallel tracks and in opposite directions, then time taken by them cross each other

$$= \frac{\textit{Sum of their individual lengths}}{\textit{Sum of their speeds}}$$

A train of length 'l' metres, travelling with a speed of 'x' m/s crosses a man travelling with a speed of 'y' m/s, then

- If the men is coming from opposite directions then time taken by the train to cross the man = $\frac{l}{x+y}$
- If the man is travelling in the same direction as that of the train, then time taken by the train to cross the man = $\frac{l}{x-y}$

BOAT AND STREAM

Let the speed of a boat in still water be 'b' km/h and speed of stream = 's' km/h. Then,

- Upstream speed of boat = (b – s)
- Downstream speed of boat = (b + s)
- Speed of boat in still water
  = b = $\frac{(\textit{Downstream speed} + \textit{Upstream speed})}{2}$
- Speed of stream
  = s = $\frac{(\textit{Downstream speed} - \textit{Upstream speed})}{2}$

CIRCULAR RACE

If 'A' and 'B' started running on a circular track of 'L' metres at a speed of 'p' m/s and 'q' m/s, respectively, then number of distinct meeting points on the circular track can be calculated as:

	Time taken by 'A' and 'B' to meet for the first time anywhere on the track	Time taken by 'A' and 'B' to meet for the first time at the starting point
'A' and 'B' are running in the same direction	$\frac{L}{\mid p - q \mid}$	LCM of $\left\{\frac{L}{p}, \frac{L}{q}\right\}$
'A' and 'B' are running in the opposite direction	$\frac{L}{p + q}$	LCM of $\left\{\frac{L}{p}, \frac{L}{q}\right\}$

If the two persons are running with speed of 'a' m/s and 'b' m/s, then calculate the simplest ratio of a:b and the following results can be used,

Case 1: When the runners are running in the opposite direction, then number of distinct meeting points = a + b (where 'a' and 'b' are the value from simplest ratio)

Case 2: When the runners are running in the same direction, then number of distinct meeting points = $|a - b|$ (where 'a' and 'b' are the value from simplest ratio)

If the difference between 'a' and 'b' is odd, then the runners will never meet at diametrically opposite points.

11 TIME & WORK

1. If 'M' persons can complete a piece of work in 'N' days while 'P' persons can complete the same work in 'Q' days and efficiency of each person is the same, then
   Total work = M × N = P × Q
2. If 'M_1' workers working 'H_1' hours per day can complete a piece of work in 'D_1' days while 'M_2' workers working 'H_2' hours per day can complete a piece of work in 'D_2' days and efficiency of every man is the same, then
   Total Work = $M_1 \times D_1 \times H_1 = M_2 \times D_2 \times H_2$
3. If 'M' men or 'W' women can complete a piece of work in 'X' days such that efficiency of a man and a woman is 'm' units per day and 'w' units per day, respectively, then;
   Total work = M × m × X = W × w × X
   Or, $\frac{m}{w} = \frac{W}{M}$
   Or, $\frac{efficiency\ of\ a\ man}{efficiency\ of\ a\ woman} = \frac{Number\ of\ women}{Number\ of\ men}$
4. If 'M_1' men and 'W_1' women can complete a work in 'D_1' days while 'M_2' men and 'W_2' women can complete the work in 'D_2' days, and efficiency of each men is 'm' units per day while that of each women is 'w' units per day, then
   $(M_1 \times m + W_1 \times w) \times D_1$
   $= (M_2 \times m + W_2 \times w) \times D_2$
5. If 'M_1' workers working 'H_1' hours per day can complete of 'W_1'work in 'D_1' days while 'M_2' workers working 'H_2' hours per day can complete 'W_2' of work in 'D_2' days and efficiency of every man is the same, then
   $$\frac{M_1 \times D_1 \times H_1}{W_1} = \frac{M_2 \times D_2 \times H_2}{W_2}$$
6. A certain number of M_1 men finish a task W_1 in D_1 days, putting in H_1 hours of work each day, and they earn a wage of Rs. R_1. Similarly, another group of M_2men complete a task W_2 in D_2 days, working H_2 hours per day, and they earn Rs. R_2 as their wage.
   $$\frac{M_1 \times D_1 \times H_1}{W_1 \times R_1} = \frac{M_2 \times D_2 \times H_2}{W_2 \times R_2}$$

12 PERMUTATION & COMBINATION

FACTORIAL NOTATION

The continued product of first 'n' natural numbers is called 'n-factorial' and is denoted as n!.

n! = n (n – 1) (n – 2)…….3.2.1

Points to Remember:

- 0! = 1
- Factorials of only natural numbers are defined.
- n! = n × (n – 1)!
  i.e. 6! = 6 × 5! or 8! = 8 × 7!
- Remember : 0! = 1, 1! = 1, 2! = 2, 3! = 6, 4! = 24, 5! = 120, 6! = 720

PERMUTATIONS

The number of permutations of n different things taken r at a time is ^nP_r, where $^nP_r = \frac{n!}{(n-r)!}$, where 'n' is the total number of items, 'r' is the number of items you're arranging.

Circular Permutation Formula: The number of ways to arrange 'n' distinct objects in a circle is given by **(n - 1)!** when rotations are considered identical. Remember that here clockwise and anti-clockwise arrangements are considered different.

- If we arrange flowers or garland beads in a necklace, then there is no distinction between clockwise & anticlockwise direction. So the formula becomes $\frac{(n-1)!}{2}$

COMBINATIONS

Selecting 'r' things out of 'n' distinct things is denoted as : ^nC_r or C (n, r)and

$$^nC_r = \frac{n!}{r!(n-r)!} = \frac{n(n-1)(n-2)....(n-r+1)}{r!}$$

- The number of combinations of 'n' distinct things taken 'r' at a time when 'p' particular things are always included $= {}^{(n-p)}C_{(r-p)}$
- The number of combinations of 'n' distinct things taken 'r' at a time when 'p' particular things are always excluded $= {}^{(n-p)}C_r$

The following results must be remembered:

- Given a set of n points in a plane, with the condition that no three of them are collinear:
  (a) Number of straight lines that can be formed: Number of ways by which we can select any two points gives the total number of straight lines $= {}^nC_2$.
  (b) Number of triangles that can be formed: Number of ways by which we can select any three non-collinear points gives total number of triangles $= {}^nC_3$
  (c) The total number of diagonals in a polygon with n sides:
  Number of diagonals = Total lines – (number of sides of polygon)
  $= {}^nC_2 - n$
- Given a set of n points in a plane, with the condition that m points of them are collinear:
  (a) Number of straight lines that can be formed:
  Number of ways by which we can select any two points gives the total number of straight lines
  $$= {}^nC_2 - {}^mC_2 + 1$$
  (b) Number of triangles that can be formed:
  Number of ways by which we can select any three non-collinear points gives total number of triangles
  $$= {}^nC_3 - {}^mC_3$$

GAP METHOD

If you want to consider arrangements of some items when no two of some specified items are together.

To arrange 'n' different things in such a way that no two of the 'r' things are together, then we arrange the 'r' things in gaps created by arranging remaining (n - r) things.

PERMUTATION OF ALIKE OBJECTS

When you want to find the number of permutations of a set of objects, some of which are alike, you can use the concept of permutations with repetition. The formula for permutations of alike objects is:

$$P(n; n_1, n_2, n_3, \ldots, n_k) = \frac{n!}{n_1!\, n_2!\, n_3! \ldots n_k!}$$

where P represents the number of permutations, n is the total number of objects in the sets $n_1, n_2, n_3, \ldots, n_k$ of similar type.

SUM OF NUMBERS

Formula for the Sum (S):

The formula to find the sum of all numbers formed by permuting the digits of a set is given by:

$S = (n - 1)! \times (10^0 + 10^1 + 10^2 + \ldots + 10^{n-1}) \times$ (Sum of numbers),

where 'n' is the number of digits in the set.

13 PROBABILITY

$$\text{Probability} = \frac{\text{Number of favourable outcomes}}{\text{Total number of outcomes}}$$

TOSSING OF COINS

When working with coins in probability, we often consider a fair coin, which is a coin with two equally likely outcomes: Heads (H) and Tails (T).

- **Tossing a Single Coin:**
  Total number of possible outcomes = 2
  Sample Space = {H, T}
- **Tossing Two Coins:**
  Total number of possible outcomes = $2^2 = 4$
  Sample Space = {HH, HT, TH, TT}
- **Tossing Three Coins:**
  Total number of possible outcomes = $2^3 = 8$
  Sample Space = {HHH, HHT, HTH, HTT, THH, THT, TTH, TTT}

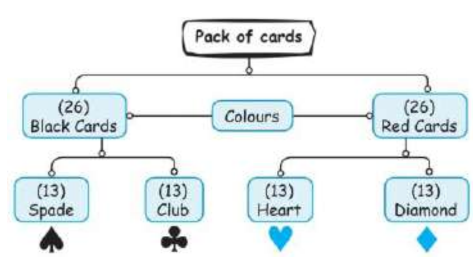
ROLLING OF DICE

Standard six-sided dice are commonly used in probability scenarios, and they have six equally likely outcomes: 1, 2, 3, 4, 5, and 6.

- **Rolling a single die**
  Total number of possible outcomes = 6
  Sample Space = {1, 2, 3, 4, 5, 6}
- **Rolling of two dice**
  Total number of possible outcomes = $6^2 = 36$

PROBABILITY RELATED WITH A DECK OF WELL SHUFFLED CARD

A standard deck has 52 playing cards which consists of four suits (Hearts, Diamonds, Clubs, and Spades), each with 13 ranks [numbers from 2 to 10, three face cards (Jack, Queen, King), and an Ace].



- Total number of cards = 52
- Number of Red Cards = Number of Black Cards = 26 each

- Hearts = Diamond = Spade = Clubs = 13 cards each
- Total number Kings = Total number of Queens = Total number of Jacks = Total number of Aces = 4
- Number of Face Cards = King (4) + Queen (4) + Jack (4) = 12

ADDITION THEOREM

- $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
- $P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(B \cap C) - P(C \cap A) + P(A \cap B \cap C)$

CONDITIONAL PROBABILITY

Conditional probability deals with the probability of an event occurring given that another event has already occurred. In other words, it quantifies the likelihood of an event happening under a specific condition or constraint. Conditional probability is denoted as P(A | B), where "P(A | B)" represents the probability of event 'A' occurring given that event 'B' has occurred.

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)} = \frac{\frac{n(A \cap B)}{n(S)}}{\frac{n(B)}{n(S)}} = \frac{n(A \cap B)}{n(B)}$$

MULTIPLICATION THEOREM

The Multiplication Theorem is used to calculate the probability of the joint occurrence of two or more events.

$(A \cap B) = A \times B = A$ and B denotes the simultaneous occurrence of A and B.

- $P(A \cap B) = P(A) \times P(B/A) = P(B) \times P(A/B)$

14 SEQUENCE & SERIES

ARITHMETIC PROGRESSION

- n^{th} term of an AP is given by
  $$T_n = a + (n - 1)d$$
  where 'a' is first term and 'd' is common difference
- Sum of the first 'n' terms of an AP
  $S_n = \frac{n}{2} \times [2a + (n-1)d] = \frac{n}{2}[a + T_n]$
  = Number of terms × (Average of first and last term)
- Arithmetic Mean (AM) for any 'n' numbers $a_1, a_2, \ldots, a_n$ is $= \frac{a_1 + a_2 + a_3 \ldots\ldots + a_n}{n}$

GEOMETRIC PROGRESSION

- n^{th} term of a GP is given by $T_n = ar^{n-1}$
- The sum of the first 'n' terms of a geometric progression (GP), often denoted as Sn is:
  $S_n = \frac{a(1 - r^n)}{1 - r}$, when r < 1
  $S_n = \frac{a(r^n - 1)}{r - 1}$, when r > 1
- Sum of infinite terms of a GP $= \frac{a}{1 - r}$, when r < 1
- Geometric Mean (GM) for any 'n' positive numbers $a_1, a_2, \ldots, a_n$ is
  $= \sqrt[n]{a_1 \times a_2 \times a_3 \times a_4 \times \ldots\ldots\ldots\ldots \times a_n}$

HARMONIC PROGRESSION

- General HP can be considered as $\frac{1}{a}, \frac{1}{a+d}$, ... where 'a' and 'd' are first term and common difference of corresponding AP.
  nth term of the HP, $T_n = \frac{1}{a + (n-1)d}$

RELATIONSHIP BETWEEN AM, GM AND HM

If AM, GM, HM are Arithmetic Mean, Geometric Mean and Harmonic Mean between any two numbers, then

- **AM ≥ GM ≥ HM** (equality holds when all terms are equal)
- **$(GM)^2$ = (AM) × (HM)** (i.e., AM, GM, HM are in GP)

15 STATISTICS

ARITHMETIC MEAN (AVERAGE)

If x_1, x_2,.....x_n be n observations, then their arithmetic mean is given by

$$\bar{X} = \frac{x_1+x_2+....+x_n}{n}$$

MEDIAN

To calculate the median of 'n' number of observations

- Arrange the observations in order, either from smallest to largest or largest to smallest.
- If 'n' is odd then, median is the middle value.

  i.e., Median (M) = Value of $\left(\frac{n+1}{2}\right)th$ observation

- If 'n' is even then, the median is the average of the two middle values.

  i.e., Median (M)

  $$= \frac{Value\ of\ \left(\frac{n}{2}\right)th\ observation + Value\ of\ \left(\frac{n+1}{2}\right)th\ observation}{2}$$

MODE

This is the number that appears most frequently in a group of numbers. It's like the most popular or common value in the set.

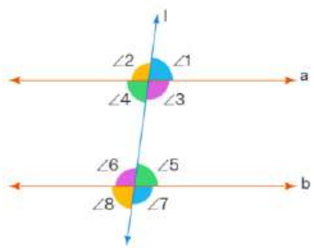
RELATION BETWEEN MEAN, MEDIAN AND MODE

The following empirical relationship exists between the Mean, Median and Mode:

2 × Mean + Mode = 3 × Median

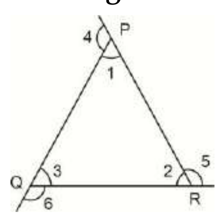
16 GEOMETRY

- When two parallel lines are cut by a transversal line:



Corresponding angles are: ∠1 & ∠5, ∠2 & ∠6, ∠3 & ∠7, ∠4 & ∠8	**The pair of corresponding angles are equal** ∠1 = ∠5, ∠2 = ∠6, ∠3 = ∠7 & ∠4 = ∠8
Alternate Interior Angles are: ∠3 and ∠6 & ∠4 and ∠5	**The pair of alternate interior angles are equal in measure, that is,** ∠3 = ∠6, and ∠4 = ∠5
Alternate Exterior Angles ∠1 and ∠8 & ∠2 and ∠7	**The pair of alternate exterior angles are equal in measure, that is,** ∠1 = ∠8, and ∠2 = ∠7
Consecutive Interior Angles ∠4 and ∠6 & ∠3 and ∠5	**The pair of consecutive interior angles are supplementary, that is,** ∠4 + ∠6 = 180°, and ∠3 + ∠5 = 180°.

- **Exterior Angle Property of a Triangle:** If a side of a triangle is produced, the exterior angle so formed is equal to the sum of two interior opposite angles. In the figure:



  ∠4 = ∠2 + ∠3

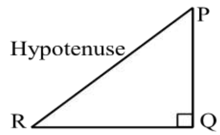
  ∠5 = ∠1 + ∠3

  ∠6 = ∠1 + ∠2

- **Pythagoras Theorem:** It states that in a right angled triangle, the square of the length of the hypotenuse (the side opposite the right angle) is equal to the sum of the squares of the lengths of the other two sides.

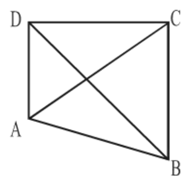
In ΔPQR, $\angle Q = 90^o$

So, $PR^2 = PQ^2 + RQ^2$



QUADRILATERALS

A quadrilateral is a four-sided polygon. Thus, it has four vertices, four sides, four angles and two diagonals.

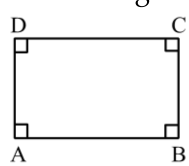


The sum of angles of quadrilateral is

$\angle A + \angle B + \angle C + \angle D = 360°$

Rectangle:

A rectangle is a parallelogram with all angles as right angles (90°).

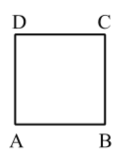


Properties:

- All properties of a parallelogram.
- All angles are 90°.
- Diagonals are equal in length.
- Diagonals bisect each other.

Square:

A square is a rectangle with all sides equal all angles equal (each 90°).

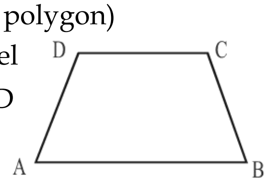


Properties:

Properties of square is same as that of the parallelogram apart from the fact that diagonals are equal and bisect each other at 90°.

Trapezium:

A trapezium, also known as a trapezoid, is a quadrilateral (a four-sided polygon) with one pair of parallel sides i.e. AB || CD while AD and CB are not parallel.



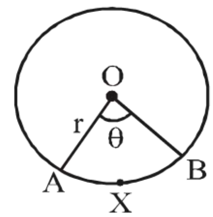
Properties:

- All sides are not equal.
- Opposite sides are not equal.
- Opposite angles are not equal.
- Diagonals are not equal.
- Diagonals do not bisect each other.
- Sum of adjacent angles is not 180°

CIRCLES

Arc: An arc is a portion of the circle's boundary. The length of an arc is proportional to the measure of the central angle that it subtends.

Sector: A sector is the region of the circle enclosed by two radii and the arc between them.

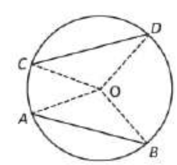
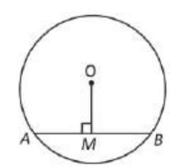
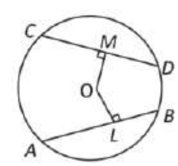


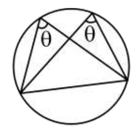
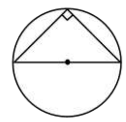
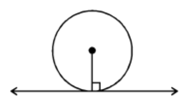
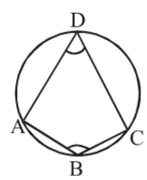
AXB is an arc of the circle.

AOB is a sector of the circle.

- The length of the arc of the sector of the circle (l) = $\frac{\theta}{360} \times 2\pi r$ (where r is the radius of the circle)
- The perimeter of the sector of the circle = $l + 2r$
- The area of a sector of a circle= $\frac{\theta}{360} \times \pi r^2$

BASIC THEOREMS & RESULTS OF CIRCLES

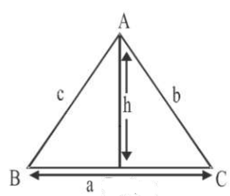
If two chords of a circle are of equal length, they will also subtend equal central angles at the centre of the circle. Its converse is also true. If AB = CD, then angle AOB = angle COD If angle AOB = angle COD, then AB = CD	
The perpendicular from the centre of a circle to a chord bisects the chord. Its converse is also true. If OM is perpendicular to AB, then AN = MB If AM = MB, then OM is perpendicular to AB.	
Two equal chords of a circle are equidistant from the centre. Its converse is also true. If AB = CD, then OL = OM If OL = OM, then AB = CD	
The angle subtended by a chord at the centre of the circle is twice the angle subtended by that chord on the circumference of the circle.	

The angles subtended by a chord in the same segment of a circle are equal.	
The angle subtended by a diameter in a semi circle is a right angle.	
The tangent line at any point of a cirlce is perpendicular to the radius through the point of contact.	
Cyclic Quadrilateral: A cyclic quadrilateral, also known as a concyclic quadrilateral, is a four-sided polygon in which all four vertices lie on the circumference of a single circle. In a cyclic quadrilateral, the sum of the measures of the opposite angle is always 180 degrees i.e. ∠A + ∠C = 180° or ∠B + ∠D = 180°	

AREA AND PERIMETER FOR DIFFERENT SHAPES

Triangle:

Formulae given below are valid for all types of triangles.



Perimeter = (a + b + c)

Area = $\frac{1}{2}$ × (base × height)

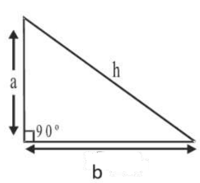
= $\frac{1}{2}$ × a × h

Heron's Formula:

- A = $\sqrt{s(s-a)(s-b)(s-c)}$

  where s = $\frac{1}{2}$ × (a + b + c) or semi-perimeter of the triangle

Right Angled Triangle:

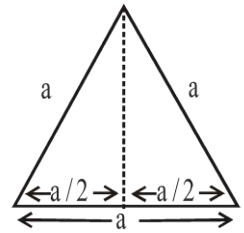


In a right angled triangle, by Pythagoras theorem (Hypotenuse)^2 = sum of squares of sides i.e.

$h^2 = a^2 + b^2$

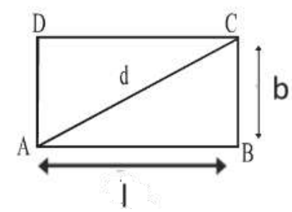
Area = A = $\frac{1}{2}$× (base × height) = $\frac{1}{2}$ × a × b

Equilateral Triangle:



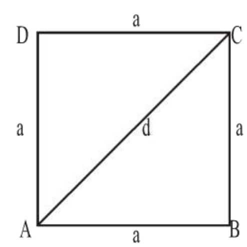
- Perimeter (P) of an equilateral triangle = 3 × (side) = 3a
- Area (A) of an equilateral triangle = $\frac{\sqrt{3}}{4}$ × (side)^2 = $\frac{\sqrt{3}}{4}$ × a^2
- Altitude (h) of an equilateral triangle = $\frac{\sqrt{3}}{2}$ × (side) = $\frac{\sqrt{3}}{2}$ × a
- Area (A) of an equilateral triangle = $\frac{(altitude)^2}{\sqrt{3}}$

Rectangle:



- Perimeter (P) = 2 × (length + breadth) = 2 × (l + b)
- Area (A) = length × breadth = l × b
- Length of Diagonal = $\sqrt{l^2 + b^2}$

Square:



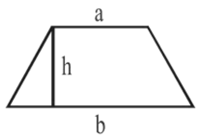
- Perimeter (P) = 4 × (side) = 4a
- Area (A) of a square = (side)^2 = a^2
- Length of diagonal = $\sqrt{2}$ × $Side = a\sqrt{2}$
- Area (A) of a square = $\frac{(Diagonal)^2}{2} = \frac{d^2}{2}$
- Area (A) of a square = $\frac{(Perimeter)^2}{16} = \frac{P^2}{16}$

Trapezium (Trapezoid):

Area (A) of a trapezium

$= \frac{1}{2} \times$ (sum of parallel sides) × (perpendicular distance between the parallel sides)

$= \frac{1}{2} \times (a + b) \times h$



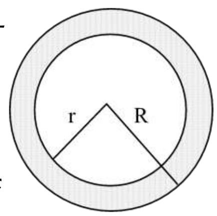
Circles:

If r is the radius of a circle, then

- Perimeter or Circumference = 2πr or πd, where d = 2r is the diameter of the circle.
- Area = πr^2 or $\frac{\pi d^2}{4}$
- Area of semi-circle = $\frac{\pi r^2}{2}$
- Area of a quadrant of a circle = $\frac{\pi r^2}{4}$

Area enclosed by two Concentric Circles:

If R and r are radii of two concentric circles, then:



Area enclosed by the two circles (Area of ring)

= Area of outer circle – Area of inner circle

$= \pi R^2 - \pi r^2 = \pi (R^2 - r^2) = \pi (R + r)(R - r)$

Rotations and Revolutions:

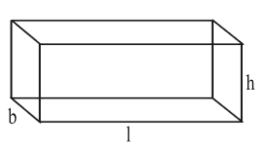
- Distance moved by a rotating wheel in one revolution is equal to the circumference of the wheel.
- The number of revolutions completed by a rotating wheel in time 't'

$= \frac{\text{Distance moved by the wheel in time 't'}}{\text{Circumference of the wheel}}$

SURFACE AREA AND VOLUME

Cuboid:

If 'l', 'b' and 'h' denote the length, breadth and height of the cuboid and 'd' denotes the body diagonal, then:



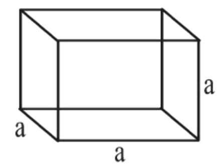
- $d = \sqrt{l^2 + b^2 + h^2}$
- Volume = $l \times b \times h = \sqrt{A_1 \times A_2 \times A_3}$

[where, A_1 = area of base or top; A_2 = area of one side face, and A_3 = area of other side face]

- Total Surface Area = 2(lb + bh + lh) $= (l + b + h)^2 - d^2$
- Area of four walls of a room = Lateral Surface area = 2(l + b)h

Cube:

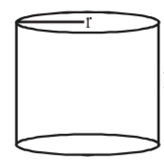
If 'a' be the edge of a cube, then



- Body diagonal of the cube = $d = \sqrt{3}a$
- Volume of the cube = $(\text{edge})^3 = a^3$
- Total surface area of the cube = $6\,(\text{edge})^2 = 6a^2$
- Lateral Surface area = $4\,(\text{edge})^2 = 4a^2$

Right Circular Cylinder:

If 'r' is the radius of base and 'h' is the height of the cylinder



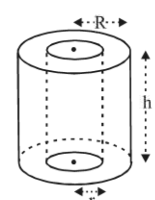
Volume of cylinder = Area of the base × height = $\pi r^2 \times h = \pi r^2 h$

Curved surface area = Circumference of the base × height = $2\pi r \times h = 2\pi rh$

- Total surface area = Area of the curved surface + Area of the two circular ends $= 2\pi rh + 2\pi r^2 = 2\pi r(h + r)$

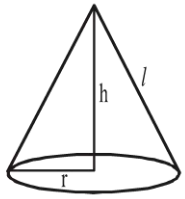
Hollow Right Circular Cylinder:

Let external radius = R, Internal radius = r and height = h



- Outer curved surface area = $2\pi Rh$
- Inner curved surface area = $2\pi rh$
- Total curved surface area = Outer curved surface area + Inner curved surface area $= 2\pi Rh + 2\pi rh = 2\pi h(R + r)$
- Area of upper and lower cross-section $= \pi R^2 - \pi r^2 = \pi(R^2 - r^2)$
- Total surface area = C.S.A. of hollow cylinder + Area of 2 circular end rings. $= 2\pi h(R + r) + 2\pi(R^2 - r^2)$
- Volume = Volume of outer cylinder – Volume of inner cylinder $= \pi R^2 h - \pi r^2 h = \pi(R^2 - r^2)h$

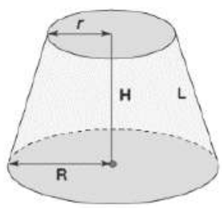
Right Circular Cone:



If r = radius of base, h = height, l = slant height

- l = slant height = $\sqrt{h^2 + r^2}$
- Volume of cone
  = $\frac{1}{3}$ × area of the base × height
  = $\frac{1}{3}$ × $\pi r^2 h$
- Area of curved surface = $\pi r l$
- Total surface area of cone = Area of the base + area of the curved surface
  = $\pi r^2 + \pi r l = \pi r(r + l)$

Frustum of a Cone:



Frustum of cone

A frustum is a three-dimensional geometric shape that results from cutting a cone into two parts with a plane parallel to its base. The portion that remains after the cut is called the frustum. The frustum of a cone has two parallel and congruent bases (circles).

'r' = radius of top, 'R' = radius of bottom,

'L' = slant height and H = Height

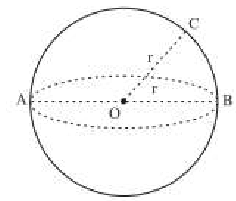
So, Curved surface area = $\Pi L(R + r)$

Total surface area = $\pi L(R + r) + \pi r^2 + \pi R^2$

Volume = $\frac{\pi H}{3} \times (r^2 + R^2 + Rr)$

Also, L = $\sqrt{H^2 + (R - r)^2}$

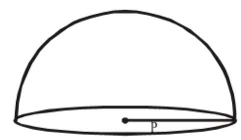
Sphere:



If 'r' = radius of the sphere, then

- Volume of sphere =$\frac{4}{3}\pi r^3$
- Surface area = $4\pi r^2$

Hemisphere:



- Volume of hemisphere = $\frac{2}{3}\pi r^3$
- Curved surface Area = $2\pi r^2$
- Total surface area = $3\pi r^2$

17 DATA INTERPRETATION

A pie chart either represent the distribution 100% of the data in terms of percentage or 360^o of the data in terms of degrees.

So, 100% = 360^o

So, 1% = 3.6^o

And, $1^o = \left(\frac{100}{360}\right)\% = \left(\frac{5}{18}\right)\%$

So, $x\% = x \times 3.6^o$

And, $x^o = \left(\frac{5}{18}\right) \times x\%$

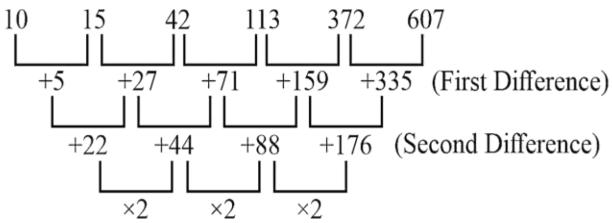
18 SERIES

The Number Series asked in CSAT exam primarily follows the following patterns:

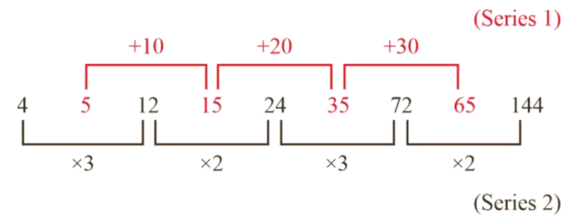
- Series following constant addition /subtraction
  Series based on constant addition of '8': 12, 20, 28, 36, 44, 52
  Series based on constant subtraction of '6': 36, 30, 24, 18, 12, 6
- Series following addition and subtraction of multiples of a certain number
  Series based on addition of consecutive multiple of 12 : 20, 32, 56, 92, 140
  Series based on addition of odd multiples of 10: 10, 20, 50, 100, 170
  Series based on addition of even multiples of 20: 20, 40, 80, 140, 220
- Series following multiplication and division.
  Series based on multiplication:
  8, 16, 48, 192, 460
  Series based on division: 360, 60, 12, 3, 1
  Series based on addition of prime numbers:
  12, 25, 42, 61, 84
  Series based on addition of squares of consecutive numbers:
  100, 125, 161, 210, 274

Series based on addition of cubes of consecutive numbers: 10, 74, 199, 415, 758

- In some cases the pattern can be seen after calculating the double difference and the pattern in the double difference can follow any of the above given patterns.



- Some series do contain two series which contain different patterns. You need to find the pattern followed in the given two series separately and then find the missing or the odd one out number.



CONTINUOUS ALPHABETICAL SERIES

In continuous series, firstly count the total given letters and try to divide the series into equal parts to find the possible patterns in the given series. For example, a series with 15 letters can be divided into smaller parts of 3 or 5 letters to find the pattern in the series.

cccbb_aa_cc_bbbaa_

⇒ **ccc / bb_ / aa_ / cc_ / bbb / aa_**

⇒ **ccc / bbb / aaa / ccc / bbb / aaa**

19 CODING & DECODING

POSITION OF ALPHABETS

In forward order:

A	B	C	D	E	F	G	H	I	J	K	L	M
1	2	3	4	5	6	7	8	9	10	11	12	13

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
14	15	16	17	18	19	20	21	22	23	24	25	26

In backward order

A	B	C	D	E	F	G	H	I	J	K	L	M
26	25	24	23	22	21	20	19	18	17	16	15	14

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
13	12	11	10	9	8	7	6	5	4	3	2	1

Backward position of letter = 27 - forward position of letter.

Opposite letters

A	B	C	D	E	F	G	H	I	J	K	L	M
Z	Y	X	W	V	U	T	S	R	Q	P	O	N

Tricks to remember the position of Alphabet:

Remembering the position of each alphabet can be quite challenging, so we often create simple tricks to help us recall their place values easily. Some of them are discussed below:

Trick 1: CFILORUX and EJOTY Formula:

C	F	I	L	O	R	U	X
3	6	9	12	15	16	18	21

Things will become easier if you remember and use these formulas. In the 1st formula, we have the position values of C, F, I, L, O, R, U, and X, which are the multiples of THREE, which will make it easier to remember the position value of the alphabet in the forward direction

E	J	O	T	Y
5	10	15	20	25

The position values of E, J, O, T and Y, which are the multiples of FIVE.

Trick 2: To find the position value in reverse order, we can use the 1st formula by reversing the alphabet as shown in the figure below:

X	U	R	O	L	I	F	C
↓	↓	↓	↓	↓	↓	↓	↓
3	6	9	12	15	18	21	24

20 CLOCK

ANGLE BETWEEN MINUTE AND HOUR HAND AT ANY POINT OF TIME

If M > H; $\theta = \frac{11}{2} \times \boldsymbol{M} - \mathbf{30} \times \boldsymbol{H}$

Here, M = minutes and H = hour

If M < H; $\theta = \mathbf{30} \times \boldsymbol{H} - \frac{11}{2} \times \boldsymbol{M}$

Here, M = minutes and H = hour

TIME GAINED OR LOST

If the clock is fast then incorrect time showed by the clock = correct time + fastness

If the clock is slow then incorrect time showed by the clock = correct time – slowness

MIRROR IMAGE OF CLOCK

Mirror image of time

= (11 hr : 60 min) – (Given time)

Example: If the time in a clock is 5 hr. 45 min. then what time does it show on the mirror?

Explanation: Mirror image of time

= (11 hr : 60 min) – (Given time)

= (11 hr : 60 min) – (5 hr : 45 min)= 6 hr : 15 min

POSITION OF CLOCK HANDS

Clock Hands Overlap: The hands of a clock overlap (form a zero-degree angle) 11 times in 12 hours, occurring once every hour, except for the overlap at exactly 12 o'clock between 12:00 and 1:00.

Clock Hands Form a Right Angle: The hands form a 90-degree angle 22 times in 12 hours, typically twice every hour, except between 2 o'clock and 4 o'clock and 8 o'clock and 10 o'clock, when they form a right angle three times.

Clock Hands Are Opposite (180° apart): The hands are 180° apart 11 times in 12 hours, occurring once every hour, except at 6 o'clock when they are exactly opposite during both 5 o'clock and 7 o'clock.

	Angle between minute and hour hand will be 0^o	Angle between minute and hour hand will be 90^o	Angle between minute and hour hand will be 180^o
In 12 hours period	11	22	11
In 24 hours period	22	44	22

21 CALENDAR

- **Ordinary Year:** An ordinary year is a year that has 365 days (52 weeks + 1 extra/odd day). In an ordinary year, the month of February has 28 days.
- **Leap Year:** A leap year is a year that has 366 days (52 weeks + 2 extra/odd days). There is an extra day, 29th February, in addition to the usual 28 days in February.

ODD DAYS

- A normal year is considered a leap year if it is divisible by 4. e.g., 2020, 2024, etc.
- For a century year (multiple of 100) to be a leap year, it should be divisible by 400 also, e.g., 2000, 2400, etc.

Months	Odd days	Months	Odd days
January	3	July	3
February	0 (ordinary year) 1 (leap year)	August	3
March	3	September	2
April	2	October	3
May	3	November	2
June	2	December	3

Odd days in Century:

Year	Ordinary Years	Leap Years	Odd Days
100	76	24	5
200	152	48	3
300	228	72	1
400	303	97	0

In an ordinary year, 1 day is gained when we move forward by one year.

In an ordinary year, 1 day is lost when we move backwards by one year.

In a leap year, 2 days are gained when we proceed forward by one year. (When we cross leap february)

In an leap year, 2 day are lost when we move backwards by one year. (When we cross leap february)

Repetition of calender year:

Year	Repetition after years
Leaps year	28
Leap year + 1	6
Leap year + 2	11
Leap year + 3	11

22 AGE BASED PROBLEMS

- If present age of a person is 'x' years, then
  Age after 'n' years = (x + n) years
  Age 'n' years ago = (x – n) years
- If present average age of a group of 'n' persons is 'm' years and 'p' persons having average age 'x' years joins the group, then new average age of the group $= \frac{n \times m + p \times x}{n + p}$ years

  If present ages of 'A' and 'B' is 'M' years and 'N' years, respectively and the ratio of their ages after 'n' years becomes p:q, then

$$\frac{M + n}{N + n} = \frac{p}{q}$$

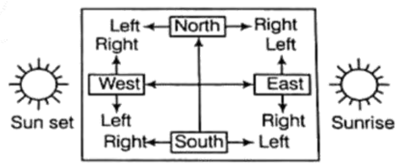
- If ratio of present ages of 'A' and 'B' is m:n, respectively and after 't' years the ratio of their ages will become a:b, then

  First, we are required to suppose that the present ages of 'A' and 'B' is 'mx' years and 'nx' years, respectively. So,

$$\frac{mx + t}{nx + t} = \frac{a}{b}$$

23 DIRECTION & DISTANCE

MAIN DIRECTIONS



Main Directions

INTERMEDIATE DIRECTIONS

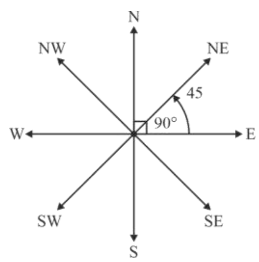
There are 4 Intermediate directions:

North - East (NE),

North - West (NW),

South - West (SW)

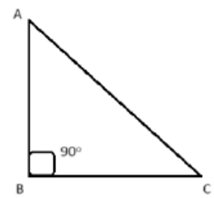
South - East (SE)



Angle formed between two main directions is 90° and the angle formed between the main direction and the intermediate direction is 45°. Following figure will help us to understand it more.

SHORTEST DISTANCE

To find the shortest distance we need to know about Pythagoras theorem:



Here, AB = perpendicular,

BC = Base

AC = Hypotenuse

Angle B = 90°

Now, by Pythagoras theorem shortest distance between point A and C

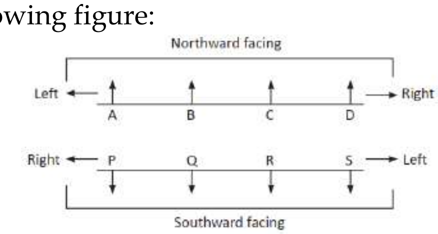
$$AC = \sqrt{(AB)^2 + (BC)^2}$$

24 SITTING ARRANGEMENT

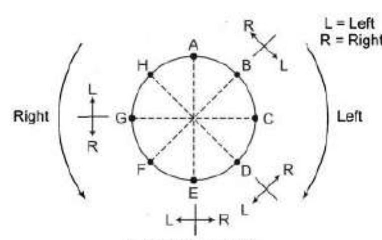
LINEAR ARRANGEMENT

In the Linear Arrangement type of puzzles, you need to arrange objects or people in a straight line. This line can be either horizontal (side by side) or vertical (one above the other). **The following facts are necessary to solve these kinds of questions:**

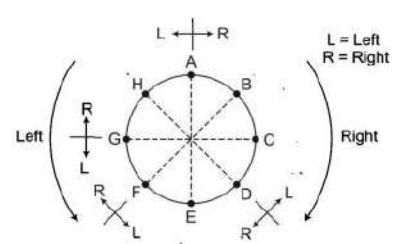
If A, B, C and D are facing toward the south direction and P, Q, R and S are facing toward the north direction in a line then positions at their left and the right will be as shown in the following figure:



CIRCULAR ARRANGEMENT



Facing the centre



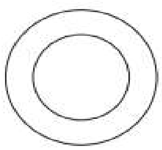
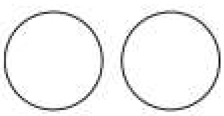
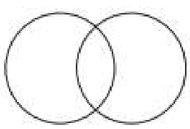
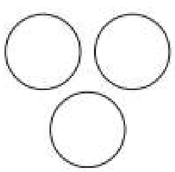
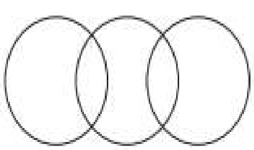
Facing the direction opposite to centre

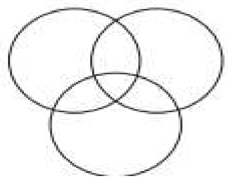
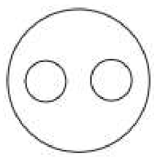
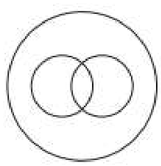
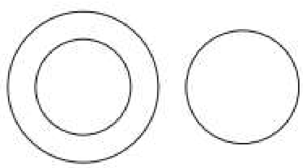
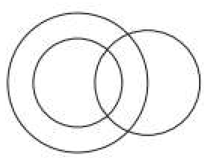
25 RANKING

POSITION TEST

- Rank/Position from Left/Top
  = Total – Rank from Right/Bottom + 1
- Rank/Position from Right/ Bottom
  = Total – Rank fromLeft/Top + 1
- Total Number of persons in Queue/Row
  = Position from Left + Position from Right – 1
- Maximum number of persons in a row
  = (Position of Person 1 from Left/Top)
  + (Position of Person 2 from Right/Bottom)
  + (Middle Places)
- Minimum number of persons in a row
  = (Position of Person 1 from Left/Top)
  + (Position of Person 2 from Right/Bottom)
  – (Middle Places) – 2

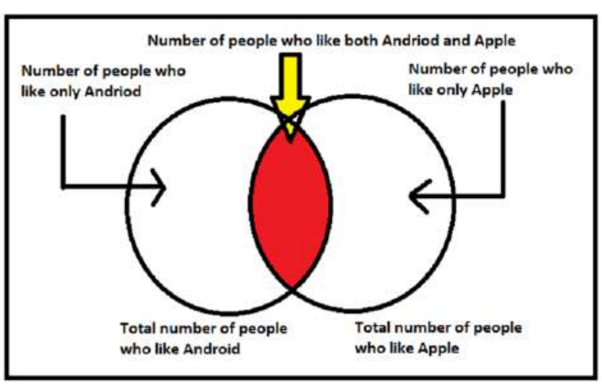
26 VENN DIAGRAM

Venn Diagram	Relationship
	This diagram shows that a group is totally inserted into other but are not equal. **For example:** The relationship between tree and banyan tree.
	This diagram indicates that two groups have no connection, and there are no shared elements between them. **For example:** Relationship between trees and animals.
	This diagram illustrates that no single group is completely within another, but they are connected to each other to some extent. **For example:** Teachers and Authors.
	This diagram illustrates that three groups have no connection, and there are no shared elements between them. **For example:** Men, Animals and Birds.
	This diagram illustrates that two groups are somewhat connected to the third group but are independent of each other. **For example:** Employed, Graduate and Unemployed.

	This diagram shows three separate groups partly related to each other. **For example:** Persons who speak Hindi, English and Punjabi.
	This diagram demonstrates that two distinct things are both part of a larger group. **For example:** Human, Doctors and Engineers.
	This diagram indicates that two sets are part of a larger group, and there are shared items between these two sets within the larger group. **For example:** Human, Graduate and Employed.
	If one group is inside another group, and a third group is completely separate from the first two, you can illustrate this relationship with a diagram. **For example:** Male, Boys and Female.
	When one group is part of another group, and a third group is related to both of them to some extent, you can represent this relationship with this diagram. **For example:** Triangle, Right angle triangle and Isosceles triangle.

VENN DIAGRAM FOR 2 VARIABLES

There are 'N' number of people in a village such that each of them like at least one of the two phones i.e. android or apple. The representation of this type of data can be given as follows:



Total number of people in the village (N)

= Number of people who like only Android

+ Number of people who like only Apple

+ Number of people who like Android and Apple

n(A) = Total number of people who like Apple

$$\mathbf{n(A) = \left(\begin{array}{c}\text{Number of people}\\ \text{who like only Apple}\end{array}\right) + n(A \cap B)}$$

n(B) = Total number of people who like Android

$$\mathbf{n(B) = \left(\begin{array}{c}\text{Number of people}\\ \text{who like only Android}\end{array}\right) + n(A \cap B)}$$

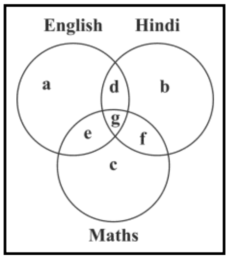
n(A ∩ B) = Number of people who like both Apple and Android

n(A U B) = Total number of people in the village = N

$$\mathbf{n(A \cup B) = n(A) + n(B) - n(A \cap B)}$$

VENN DIAGRAM FOR 3 VARIABLES

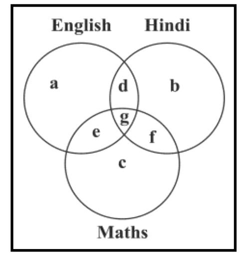
A survey was conducted in a school of 'Z' students such that each student in the school like one of the three subjects i.e. English, Hindi or Maths. The given figure shows the pictorial representation of the same.



$$n(A \cup B \cup C) = \begin{bmatrix} n(A) \\ + \\ n(B) \\ + \\ n(C) \end{bmatrix} - \begin{bmatrix} n(A \cap B) \\ + \\ n(B \cap C) \\ + \\ n(C \cap A) \end{bmatrix} + n(A \cap B \cap C)$$

Here,

- $n(A \cup B \cup C) = Z$
  = Total number of students in the school.
- $n(A)$ = Number of students who like English
- $n(B)$ = Number of students who like Hindi
- $n(C)$ = Number of students who like Maths
- $n(A \cap B)$ = Number of students who like bothEnglish and Hindi
- $n(B \cap C)$ = Number of students who like both Hindi and Maths
- $n(C \cap A)$ = Number of students who like both Maths and English
- $n(A \cap B \cap C)$ = Number of students who like all three subjects.
- 'a' = Number of students who like only English



- 'b' = Number of students who like only Hindi
- 'c' = Number of people who like only Maths
- 'd' = Number of students who like both English and Hindi but not Maths
- 'e' = Number of students who like both English and Maths but not Hindi
- 'f' = Number of students who like both Maths nd Hindi but not English
- 'g' = Number of students who like all three subjects.

Total number of students surveyed

$$= Z = (a + b + c) + (d + e + f) + g$$

Here,

- $(a + b + c)$ = Number of students who like exactly one subject.
- $(d + e + f)$ = Number of students who like exactly two subjects
- **Total number of students surveyed**

$$= \begin{bmatrix} \text{Number of} \\ \text{students} \\ \text{who like} \\ \text{exactly} \\ \text{one subject} \end{bmatrix} + \begin{bmatrix} \text{Number of} \\ \text{students} \\ \text{who like} \\ \text{exactly} \\ \text{two subjects} \end{bmatrix} + \begin{bmatrix} \text{Number of} \\ \text{students} \\ \text{who like} \\ \text{all} \\ \text{three subjects.} \end{bmatrix}$$

27 INEQUALITIES

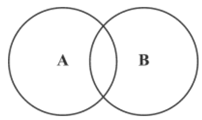
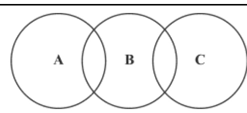
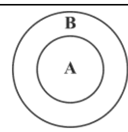
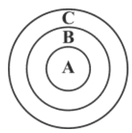
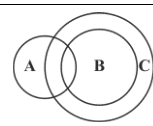
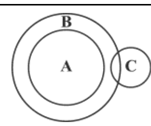
Priority of the inequality symbol is as:
>, ≥ and =

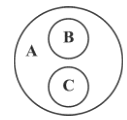
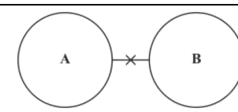
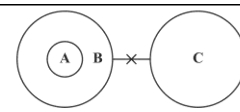
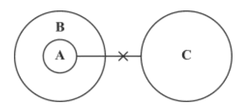
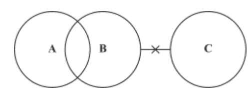
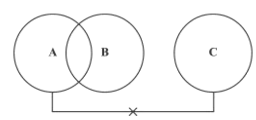
Statement and Conclusion:

Statement	Conclusion
A > B > C	A > C
A ≥ B > C	A > C
A > B ≥ C	A > C
A = B > C	A > C
A > B = C	A > C
A ≥ B = C	A ≥ C or A > C or A = C

Statement	Conclusion
A = B ≥ C	A ≥ C or A > C or A = C
A ≥ B ≥ C	A ≥ C or A > C or A = C
A > B < C	NO CONCLUSION
A ≥ B < C	NO CONCLUSION
A > B ≤ C	NO CONCLUSION
A < B > C	NO CONCLUSION
A ≤ B > C	NO CONCLUSION
A < B ≥ C	NO CONCLUSION

28 SYLLOGISM

Statement	Venn Diagram
Some 'A' are 'B'	
Some 'A' are 'B' and Some 'B' are 'C'	
All 'A' are 'B'	
All 'A' are 'B' and All 'B' are 'C'	
Some 'A' are 'B' and All 'B' are 'C'	
All 'A' are 'B' and Some 'B' are 'C'	

Statement	Venn Diagram
All 'B' are 'A' and All 'C' are 'A'	
No 'A' are 'B'	
All 'A' are 'B' and No 'B' are 'C'	
All 'A' are 'B' and No 'A' are 'C'	
Some 'A' are 'B' and No 'B' are 'C'	
Some 'A' are 'B' and No 'A' are 'C'	

29 CUBES & DICE

If a larger cube of edge length 'M' units is painted from all sides and is cut into 'n' identical smaller cubes of edge length 'N' units, then

$$n = \frac{M \times M \times M}{N \times N \times N}$$

- Total number of cubes = n^3
- Number of cubes with '0' face painted = Cubes which are in second layer or inside = $(n - 2)^3$
- Number of cubes with exactly one face painted = Cubes on the surface or face = $6(n - 2)^2$
- Number of cubes with exactly two faces painted = Number of cubes on the edges = **12(n – 2)**
- Number of cubes with exactly three faces painted = Number of cubes on the vertices = **8**

CUTTING OF A CUBOID

- When a cuboid of the L × B × H, is cut into smaller cubes (edge length 'a') of equal volume, then total number of cubes formed $= \frac{L \times B \times H}{a^3}$

If a cuboid of dimension L × B × H is painted on all sides and is then cut into smaller cubes of dimension 1 × 1 × 1, then

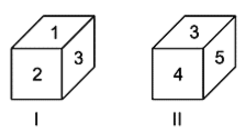
Number of cubes with '0' face painted = Cubes which are in second layer or inside layer = **(L – 2) × (B – 2) × (H – 2)**

- Number of cubes with exactly one face painted = Cubes on the surface or face **= 2 × [(L – 2) × (B – 2) + (B – 2) × (H – 2) + (L – 2) × (H – 2)]**
- Number of cubes with exactly two faces painted = Number of cubes on the edges **= 4 × (L + B + H – 6)**
- Number of cubes with exactly three faces painted = Number of cubes on the vertices **= 8**

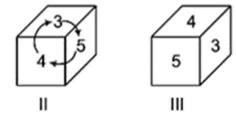
DICE

Finding Digits / Dots / Words / Letters / Figures/Symbols on Opposite Faces of a Dice

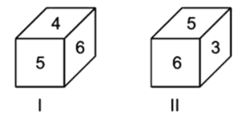
- **Case 1: Common Digit on Different Faces**
  When the same number appears on different faces in two dice positions, rotate the dice from the common number in a clockwise direction.
  For example: If 3 is the common digit, and rotating clockwise shows 1 and 2 on one dice and 4 and 5 on another, then 2 is opposite 5, and 3 is opposite 6.



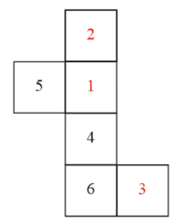
When digits move clockwise.



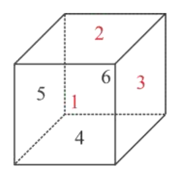
- **Case 2: Two Common Digits**
  When two numbers are common in two positions of the dice, the remaining uncommon numbers are opposite to each other.
  For example: If 5 and 6 are common in two positions, and the remaining numbers are 3 and 4, then 3 is opposite to 4.



When dice is cut open the alternate places will be opposite to each other



Here the opposites are 2-4, 1-6 and 3-5



30 READING COMPREHENSION

HOW TO APPROACH READING COMPREHENSION IN CSAT?

Solving Reading comprehension in the CSAT can be challenging, but here are some tips that you can use to improve your performance

- **Improve your reading speed and comprehension skills:** Reading is a skill that you can improve with practice. Try to read as much as possible and pay attention to the structure of the passages. Focus on understanding the main idea and the supporting details.
- **Highlight or underline important information:** When you come across important information, such as dates, names, and key concepts, highlight or underline them. This will help you to find them quickly when you need to answer the questions.
- **Identify the type of question being asked:** There are different types of questions that can be asked, such as factual questions, inference questions, and vocabulary

questions.Understanding the type of question being asked will help you to approach the question correctly.

- **Practise previous year question papers:** Practising previous year question papers will give you an idea of the type of questions that can be asked in the exam. This will also help you to develop your time management skills.
- **Look for context clues:** Sometimes, unfamiliar words or phrases may appear in the passage. If you come across such words, look for context clues such as synonyms or antonyms, to help you understand the meaning of the word or phrase.
- **Focus on the structure of the passage:** The structure of the passage can give you important clues about the author's purpose and main ideas. Look for transition words, such as "however" and "therefore," to understand the relationships between different ideas.
- **Make educated guesses:** If you are unsure about an answer, try to make an educated guess by eliminating obviously incorrect answers and making an educated guess based on the information you have.
- **Practice active reading:** When reading a passage, try to actively engage with the text by asking yourself questions and making connections to your own experiences and knowledge. This will help you to understand the passage better and retain the information more effectively.
- **Manage your time wisely:** Time management is crucial in the UPSC CSE CSAT exam. Make sure to allocate your time wisely, and don't spend too much time on any one question. If you get stuck on a question,move on and come back to it later if you have time.

Apart from these tips, as a matter of last resort; elimination techniques, as discussed below, also help candidates to arrive at the correct answer in a limited time period.

OPTION ELIMINATION IN READING COMPREHENSION

- In any exam which tests your reading comprehension, including UPSC-CSAT, there are five primary criterias which helps you decide that a particular option is incorrect.
- Often, it is observed in UPSC-CSAT that a candidate is able to eliminate two options comfortably. But UPSC gives very close choices for the remaining two options which makes it really difficult to eliminate the third option to arrive at the answer, in a limited time frame.
- In such situations having predefined criteria as to in which all ways an option can be incorrect will give candidates much needed clarity of thought and ultimately increase their speed in solving reading comprehension based questions.
- However, candidates should keep in mind that first they should always attempt to arrive at the right answer without thinking about wrong options. If that does not work, then only one should resort to elimination techniques.

FIVE CRITERIA TO ELIMINATE OPTIONS

1. Out of the Scope of Passage

- This refers to options, which are not even mentioned in the passage explicitly or implicitly, that is, you find no direct or indirect reference of the option in the passage.

Let us consider following example to understand this:

Passage

Humans often seek change due to a combination of innate curiosity, a desire for improvement, and a coping mechanism for discomfort or dissatisfaction. Evolutionarily, adaptability has been crucial for survival, driving the inclination to modify circumstances. In this ever-evolving journey of life, the Japanese philosophy of Uketamo emerges as a beacon of light. Uketamo, translated loosely as “to accept.”

The philosophy teaches that all things, whether positive or challenging, are fleeting. It encourages individuals to acknowledge and receive both the joys and sorrows of life without resistance, fostering a profound sense of equilibrium.

Q. Which of the following statements most accurately represents the central idea of the passage?

(a) Changes in human lives are often desirable.

(b) Changes should be avoided to bring about the sense of equilibrium.

(c) Acceptance towards life's ups and downs can lead to peace.

(d) Depression is a modern day phenomenon, which was not even there in the past.

Answer: (c)

Here, one can easily eliminate option (d) since it is out of the scope of the passage. Passage talks about change and how Uketamo helps individuals to deal with the changes. While option (d) talks about depression, which finds no direct or indirect mention in the passage, hence this option is out of the scope of the passage.

2. Extreme options

- This refers to an option which has been arrived at after making extreme assumptions or very long inferences with respect to the content given in the passage.
- To put it in simpler terms too one needs to apply way too many logics in addition to the information given in the passage to see this particular option as true.

Let us consider following example to understand this:

Passage

Recent advancements in artificial intelligence (AI) have led to significant progress in the field of renewable energy. AI algorithms are helping researchers design more efficient solar panels, predict wind patterns for better turbine placement, and develop smart grids that optimise energy distribution. While the potential of AI for tackling climate change is undeniable, some experts warn that its increasing dependence on fossil fuels for data processing and hardware production could ultimately undermine its environmental benefits.

Q. Based on the above passage, which of the following assumption(s) is/are valid?

(a) AI will ultimately enable renewable technology to replace fossil fuels completly in the coming future.

(b) Data processing requires extensive computer infrastructure powered by fossil fuels.

(c) Manufacturing of hardware components for AI systems heavily pollutes the environment.

(d) Both (b) & (c)

Answer: (d)

Here, option (a) can be eliminated since it makes an extreme assumption. At First, the extreme assumption is that AI will enable renewable energy to replace fossil fuels. We cannot conclude this based on the information given in the passage. Passage only talks about AI making renewable energy technology more efficient.

Secondly, Way too long logic is applied here in assuming whether renewable energy will replace fossil fuels or not. This is nowhere explicitly mentioned in the passage. Hence, this option is an extreme option.

3. Partially Correct

- This refers to options which may appear true at first place, but only a part of the option, say a word or two makes this option incorrect.
- Hence to eliminate such options a careful, word to word reading is required. Part, which makes this option incorrect, can be an extreme word or something not mentioned in the passage even implicitly.

Let us consider following example to understand this:

Passage

In the landmark Keshavananda Bharti Case, the Basic Structure Doctrine emerged as a judicial doctrine safeguarding the core principles of the Constitution. The judiciary asserted that while Parliament has the power to amend the Constitution, it cannot alter its basic structure. This doctrine, articulated by the Supreme Court of India, ensures the preservation of essential features such as democracy, rule of law, and individual liberties. Keshavananda Bharti's case marked a pivotal moment in constitutional jurisprudence, establishing a framework that guards against arbitrary amendments threatening the foundational integrity of the Constitution.

Q. Which of the following assumptions is implicit in the passage?

(a) The Basic Structure Doctrine may require periodic review to adapt to evolving constitutional principles.

(b) In the landmark Keshavananda Bharti Case, the Basic Structure Doctrine emerged as the only judicial doctrine safeguarding the core principles of the Constitution.

(c) The preservation of essential features like democracy and individual liberties is a universally uncontested aspect of constitutional jurisprudence.

(d) The Basic Structure Doctrine, as articulated in the Keshavananda Bharti Case, is immune to legal challenges.

Answer: (a)

Here, we can eliminate option (b) since it is a rotten fruit. At first it appears correct since it is explicitly mentioned in the opening remarks of the passage. But only one word 'only' makes this option an incorrect one.

Based on the information given in the passage, we can not infer whether it is the 'only' judicial doctrine safeguarding core principles of the constitution or not. There may be other such doctrines as well.

4. Contextually Wrong Options

- This refers to options which are true in itself based on the information in the passage, when examined independently. But they do not specifically answer the question.
- For instance, the question is asking the underlying tone of the passage, but the option simply states one of the facts mentioned in the passage and not the underlying tone.

Let us consider following example to understand this:

Passage

Philosophers through the ages have constantly reminded us of this underlying universal principle that we are a small but integral part of this web of life. "That which isn't good for the hive, isn't good for the bee," said Marcus Aurelius. Just as each organ in our body has its own individual function, but always towards the wellbeing of the whole; each of us has a role, and any action that is not in the benefit of the collective, ultimately cannot benefit the individual. Only when we truly learn to recognise that we are not separate from nature but a part of this one life, can we positively alter the way we consume,

Q. In the context of the passage, what is the most logical inference that can be drawn?

(a) Recent emphasis on individual rights goes against the idea of collective benefits.

(b) Collective benefits should be placed over individual benefits.

(c) Each one of us has a role which ultimately leads to the benefit of the collective

(d) We are separate from nature but we must act in sync with nature.

Answer: (b)

Here, at first instance option (c) may appear correct since it is explicitly mentioned in the passage. But upon careful reading of the question we recognize that the question is asking for the most logical inference.

Option (c) is a straight fact stated based on information given in the passage. Inference is something which we derive based on logical and rational reasoning and is not mentioned directly in the passage. Hence, option (c) is contextually wrong.

5. True in Real World but Incorrect as per passage

- This refers to options which are true in real world situations and normal circumstances. These options are true based on common sense and general knowledge.
- But based on the information given in the passage and the question that follows, these options are wrong. Hence one needs to be always aware of the fact that answers need to be based on the passage solely in order to eliminate such options.

Let us consider following example to understand this:

Passage

As India's Central Electricity Authority (CEA) marks its 50th year, its vital role in shaping the nation's energy backbone shines brightly. From fostering grid expansion to ensuring grid stability, the CEA has facilitated affordable electricity access for millions. Its technical expertise continues to be pivotal, even as the landscape shifts towards renewables and climate concerns. Balancing these new demands with its traditional strengths will be crucial for the CEA's future impact.

Q. What is the most logical and crucial message conveyed by the passage?

(a) CEA is a statutory organisation constituted under Electricity Supply Act, 1948

(b) Transitioning to renewables necessitates dismantling the CEA's traditional framework and starting anew.

(c) Balancing affordability, renewable integration, and climate goals will define the CEA's future effectiveness.

(d) CEA advises government on policy matters and formulates plans for development of electricity systems

Answer: (c)

Here, if we rely on pre-existing general knowledge that we have based on our study of GS subjects, options (a) and (d) are true

But based on the information given in the passage and the question that follows, , we simply can not determine whether these options are correct or not.

While attempting the CSAT, in a limited time frame, in a hurry it is a possibility that one marks one of these options as correct. Especially if you are just skimming through the passage and not reading both passage and the question carefully.