IPMAT QUANTITATIVE APTITUDE (FORMULAE BOOK)

iQuanta
Building Learning Networks

USEFUL FORMULAE & CONCEPTS FOR

IPMAT
QUANTITATIVE APTITUDE

An iQuanta Presentation

IPMAT COURSE
By iQuanta

INDRAJEET SINGH
Founder & CEO iQuanta
The Wizard of Quant

YOGESH JOSHI
SNAP: 99%ile
CAT QA: 98%ile
SIBM Pune & SCMHRD Convert

ASHISH MEHTA
CAT & IPMAT
QA & LRDI Trainer

ANAND SHUKLA
CAT & IPMAT
VARC Trainer

Quant:
150 hours of classes + 1000 Videos

LRDI:
100 hours of classes + 250 Videos

VARC:
100 hours of classes + 300 Videos including tests.

SUMMARY
1500+ videos + 350+ hours of interactive Live sessions which will include both concepts, basics and application of concepts

PRACTICE
1500+ QA | 1000+ LRDI | 1000+ VARC

MOCKS
30 Full Mocks | 10 IPMAT Indore | 10 IPMAT Rohtak | 10 JIMAT Mocks.

Enroll Now | Visit www.iQuanta.in/ipmat

For More Info Contact Us: +91 9289442304

INDEX

www.iQuanta.in

NUMBER SYSTEM

Important points to remember:

1. The product of ‘n’ consecutive natural numbers is always divisible by n!

2. Square of any natural number can be written in the form of 3n or 3n+1.

3. Square of a natural number can only end in 0, 1, 4, 5, 6 or 9. Second last digit of a square of a natural number is always even except when last digit is 6. If the last digit is 5, second last digit has to be 2.

4. Any prime number greater than 3 can be written as 6k+1 or 6k-1.

5. Any two-digit number ‘mn’ can effectively be written as 10m+n and a three-digit number ‘lmn’ can effectively be written as 100l+10m+n.

6. Sum of 1st n natural number, $1+2+3+.....+n = \Sigma n = n(n+1)/2$

7. Sum of 1st n positive even numbers, $2+4+6\text{-------}+2n = n(n+1)$

8. Sum of 1st n positive odd numbers, $1+3+5+\text{------}+(2n – 1) = n^2$

9. Sum of squares of 1st n natural numbers:
$1^2+2^2+3^2+\text{----}+n^2 = n(n+1)(2n+1)/6$

10. Sum of cubes of 1^{st} n natural numbers:
$1^3+2^3+3^3+\text{---------}+n^3 = (\Sigma n)^2 = [n(n+1)/2]^2$

11. 0 and 1 are neither composite nor prime.

12. There are 25 prime numbers less than 100.

13. There are 15 prime numbers less than 50.

Divisibility rules

2 – when last digit of the number is 0, 2, 4, 6, 8.
4 – when last two digits of the number is 00 or divisible by 4.
8 - when the last three digits of the number is 000 or divisible by 8.
5 – when last digit is 0 or 5.
2^n - when last n digits of the numbers are divisible by 2^n.
5^n - when last n digits of the number are divisible by 5^n.

Divisibility rule for 3 and 9
3 – Sum of the digits should be divisible by 3.
9 – Sum of digits should be divisible by 9.

Divisibility rule for 7 and 11
7 - the difference between twice the unit digit of the given number and the remaining part of the given number should be a multiple of 7 or it should be equal to 0".
For example, 798 is divisible by 7.
11 - if the difference between the sums of the alternate digits of the given number is either 0 or divisible by 11, then the number is divisible by 11.

Divisibility rules of 6, 12, 14, 15, 18, etc.
Whenever we have to check the divisibility of a number N by a composite number C, the number N should be divisible by all the prime factors (the highest power of every prime factor) present in C.

Properties of factors and co-prime numbers

For any natural number $N = a^x * b^y * c^z....$, where a, b, c.... are prime numbers and x, y, z are their powers which are natural numbers. (N is prime factorized here).

Number of factors of N = (x+1) (y+1) (z+1) ….
Number of even factors = same as above, but just consider one power of 2 less while calculating.
Number of odd factors = (Total factors – even factors) OR remove 2 and its powers from the prime factorization & find factors of rest of the odd part.

Remainders and Remainder Theorems

Dividend = Divisor x Quotient + Remainder

Mod, which stands for modulus simply means 'remainder'. So, the value of a mod b is simply the remainder obtained on dividing a by b.

If Rem $[N_1/D] = R1$, Rem $[N_2/D] = R2$, ………, Rem $[N_m/D] = R_m$ then
i. Rem $[(N_1+N_2+\ldots+N_m)/D]$ = Rem $[(R_1+R_2+\ldots+R_m)/D]$
ii. Rem $[(N_1*N_2*\ldots*N_m)/D]$ = Rem $[(R_1*R_2*\ldots*R_m)/D]$

iii. **Negative Remainder:** Sometimes we use negative remainder to find the actual remainder easily. Let us try to understand it:-
We know that remainder when 19 is divided by 10 is 9 but we can also take the remainder as –1 which is (9 – 10).

Remainder Theorems:

1. Wilson's Remainder Theorem

For any prime number P, Rem $[\frac{(P-1)!}{P}]$, i.e.,
(P-1)! mod P = (P – 1) or – 1
E.g., Rem $[\frac{18!}{19}]$ = 18 or -1

2. Euler's Totient Theorem

For two coprime numbers N and D, Rem $[\frac{N^{k.E(D)}}{D}] = 1$, where k is a natural number and E(D) is Euler of the number D. (Calculation of how to calculate Euler mentioned above).

Example: What is the remainder when 47^{32} is divided by 51?
Solution: 51 = 3*17 so E (51) = $51*\frac{2}{3}*\frac{16}{17} = 32$.
We can see that 47 and 51 are coprime, so using Euler's remainder theorem,

Rem $[\frac{47^{32}}{51}]$ = 1.

Finding the Last digit or Unit's Digit (UD) of a Number:

Unit's digit of a number, i.e., the last digit is the remainder when the number is divided by 10.

E.g. Unit's digit of 2345 is 2345 mod 10 = 5
Unit's digit of (234 + 567) = Unit digit of (4 + 7) = Unit Digit of 11 = 1
Similarly, to find the unit's digit of (234*567), we just need to consider the unit's digits of these two numbers viz: 4*7 = 28. Hence the unit's digit of the given product is 8.

How to calculate the unit's digit of numbers of the form a^b such as 2^{253}, 3^{93}, 4^{74} etc.?
Case 1: When b is NOT a multiple of 4.
We find the remainder when b is divided by 4.
Let b = 4k + r, where r is the remainder when b is divided by 4, and
$0 < r < 4$.
The unit's digit of a^{4k+r} is the unit digit of a^r.

Case 2: When b is a multiple of 4.
We observe the following conditions:
Even numbers 2, 4, 6, 8 when raised to powers which are a multiple of 4 give the unit's digit as 6.
Odd numbers 3, 7, and 9 when raised to powers which are a multiple of 4 give the unit's digit as 1.
Unit's digit of a^{4k} = units digit of a^4

Finding the Last Two Digits (LTD) of a number:

Last two digits of a number is the remainder when the number is divided by 100.
E.g. LTD(123456) = 56, LTD(123*456) = LTD(23*56) = LTD(1288) = 88

How to calculate last two digits of numbers in the form a^b such as 24^{356}, 53^{903}, 79^{714} etc.?

Case 1: When the unit's digit of a is 1, multiply the ten's digit of the number with the last digit of the exponent to get the ten's digit and it is easy to understand that the unit's digit is equal to one.

Example: Find the last two digits of 21^{43}.
Solution: We know that unit's digit of the given number will be 1.
As mentioned above, to find the second last digit we need to multiply the ten's digit of the number (2) to the unit's digit of the exponent (3), 2*3 = 6.
So LTD of 21^{43} is 61.

Case 2: When a = 2^n while finding last two digits of a^b.
2^{10} = 1024, 24^1 = 24, 24^2 = 576, ………, 24^3 = xxx24, 24^4 = xxxxx76

Following the pattern, it can be noticed that,
LTD(24^{odd}) = 24 and LTD(24^{even}) = 76.

Example:
LTD(16^{125}) = LTD(2^{500}) = LTD($xx24^{50}$) = LTD(24^{even}) = 76.

Case 3: When the unit's digit of a is 5 while finding the last two digits of a^b.
LTD($xxA5^B$) = 75, when A and B are odd.
LTD($xxA5^B$) = 25, otherwise.

LTD(35^{125}) = 75, LTD(45^{242}) = 25, LTD(85^{775}) = 25, LTD(75^{364}) = 25.

LCM, HCF AND THEIR APPLICATIONS

Important points to remember:

1. For two natural numbers x and y where x = h*a and y = h*b where a, b are co-prime numbers and HCF (x, y) = h, LCM (x, y) = h*a*b and Product (x, y) = h^2*a*b
It can be noticed that:
(i) Product (x, y) = LCM (x, y) * HCF (x, y)
(ii) LCM is always a multiple of HCF.

2. If N is a positive integer which leaves remainder 'r' each time when divided by x, y or z then N = {LCM (x, y, z) * k} + r, where k is a whole number.

E.g. Find the smallest number which leaves a remainder of 3 when divided by 4, 5 or 6.
Solution: LCM(4,5,6)*1 + 3 = 63

3. If N is a positive integer which leaves remainders r_1, r_2 and r_3 when divided by x, y and z respectively, where $x - r_1 = y - r_2 = z - r_3 = r$ then N = {LCM (x, y, z) * k} - r, where k is a natural number.

E.g. Find the smallest number which when divided by 8, 9, 10 leaves remainders 3, 4, 5 respectively.
Solution: We see that 8-3 = 9-4 = 10-5 = 5
So, smallest number = LCM (8, 9, 10)*1 – 5 = 355

4. N is the greatest positive integer which divides x and y, leaving remainder r_1 and r_2 respectively, then N = HCF $(x-r_1, y-r_2)$.

5. N is the greatest positive integer which divides x, y and z, leaving a remainder r in each case, then N = HCF (y-x, z-y).

Index of Greatest Power

The highest power of a number m that can divide another number n is known as IGP of m in n.

For any prime number p, IGP(p) in n! = $[\frac{n}{p}] + [\frac{n}{p^2}] + [\frac{n}{p^3}] + [\frac{n}{p^4}]$ + ------- where [x] denotes the greatest integer less than or equal to x.
There is another way to get the IGP. It is shown in the example below.

Example: What is highest power of 2 that can divide 40!?
Solution: IGP of 2 in 40! = $[\frac{40}{2}] + [\frac{40}{2^2}] + [\frac{40}{2^3}] + [\frac{40}{2^4}] + [\frac{40}{2^5}]$ = 20+10+5+2+1 = 37

OR

$[\frac{40}{2}]$ --> $[\frac{20}{2}]$ --> $[\frac{10}{2}]$ --> $[\frac{5}{2}]$ --> $[\frac{2}{2}]$ --> 1
Answer = 20+10+5+2+1 = **37**

ARITHMETIC

- Averages
- Percentages
- SI & CI
- Profit & Loss
- Mixtures & Alligation
- Ratio & Proportion
- Time, Speed & Distance
- Races
- Time & Work

AVERAGES

$$\textbf{Average} = \frac{\textbf{Sum of all the observations}}{\textbf{Number of observations}}$$

Note: Average of a set of values always lies between minimum to maximum.
i.e., Minimum ≤ Average ≤ Maximum

Remember the following points about averages:

i. Average on 1st n natural number = $\frac{n+1}{2}$ (i.e., n(n+1)/2/n = (n+1)/2)
ii. Average of 1st n odd numbers (1, 3, 5, ….., 2n – 1) = n (i.e., $n^2/n = n$)
iii. Average of 1st n even numbers (2, 4, 6, ….., 2n) = n + 1
iv. Average of n terms in Arithmetic Progression = $\frac{n+1}{2}$th term = middle term, when n is odd.
For example: Average (3, 7, 11, 15, 19, 23, 27) = 15
v. Average of n terms in Arithmetic Progression = $\frac{\frac{n}{2}\text{th term} + \left(\frac{n}{2}+1\right)\text{th term}}{2}$ = Average of middle terms, when n is even.
For example: Average of (6, 10, 14, 18, 22, 26, 30, 34) = $\frac{18+22}{2}$ = 19
v. Average of n terms of an Arithmetic Progression = $\frac{\text{1st term}+\text{last term}}{2}$

$= \frac{\text{2nd term}+\text{2nd last term}}{2}$

$= \frac{\text{3rd term}+\text{3rd last term}}{2}$

and so on…………

vi. If each term in a set is increased by the value k, then their average is also increased by k.

vii. If each term in a set is decreased by the value k then their average is also decreased by k.
viii. If each term in a set is multiplied by the value k then their average is also multiplied by k.

ix. If each term in a set is divided by the value k then their average is also divided by k.

Concept of assumed average:

Example: Find the average of 54, 55, 57, and 61

Solution: Let us assume average is 57 (We pick the assumed average in such a way that it lies around the middle of min and max values)

Next, we find deviation of the values from this assumed average.

54 – 57 = –3

55 – 57 = –2

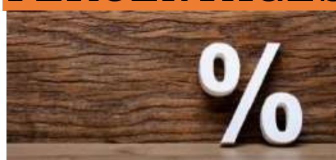
57 – 57 = 0

61 – 57 = 4

Average of all the deviations = $\frac{(-3)+(-2)+(0)+4}{4}$ = -0.25

Hence, actual average will be 57 – 0.25 = **56.75.**

PERCENTAGES



The percentage equivalents of fractions:

Fraction	Percentage	Fraction	Percentage	Fraction	Percentage
1/2	50%	1/8	12.50%	1/14	7.14%
1/3	33.33%	1/9	11.11%	1/15	6.66%
1/4	25%	1/10	10%	1/16	6.25%
1/5	20%	1/11	9.09%	1/17	5.88%
1/6	16.16%	1/12	8.33%	1/18	5.56%
1/7	14.28%	1/13	7.69%	1/19	5.26%

Important points:

i. x is what % of y = $\frac{x}{y}$*100%

ii. x% of y = y% of x

iii. x is what % more than y = $\frac{(x-y)}{y}$*100, x > y.

iv. x is what % less than y = $\frac{(y-x)}{y}$*100, x < y.

v. Multiplication Factor (MF)

For example, increase x by 10%:

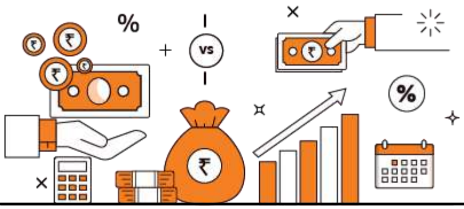
x + 10% of x = x(1+10%) = x(1 + $\frac{10}{100}$) = x(1 + 0.1) = **1.1**x
Here we are basically multiplying x by 1.1 which is known as multiplication factor for 10% increase.
So next time if we want to decrease a quantity by 10% we can directly multiply that quantity by (1 – 10%) = 0.9 and get the desired value.

E.g. Find the resultant value when100 is increased by 20%, decreased by 30% and then increased by 12%.
Solution: 100 x 1.2 x 0.7 x 1.12 = 94.08

Here are a few multiplication factors for the respective % changes:

Percentage Change	Multiplication Factor	Percentage Change	Multiplication Factor
+5%	**1.05**	-5%	**0.95**
+10%	**1.1**	-10%	**0.9**
+15%	**1.15**	-15%	**0.85**
+20%	**1.2**	-20%	**0.8**
+25%	**1.25**	-25%	**0.75**
+30%	**1.3**	-30%	**0.7**
+40%	**1.4**	-40%	**0.6**
+50%	**1.5**	-50%	**0.5**
+60%	**1.6**	-60%	**0.4**

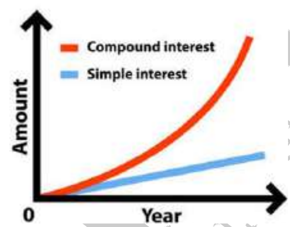
SIMPLE & COMPOUND INTEREST



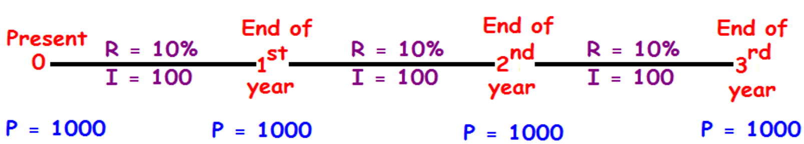
Difference & Graphical Presentation of Simple and Compound Interest:

- Simple interest is always charged on a sum(original principal) at a particular rate and specified period of time.
- Simple interest for all years is the same.

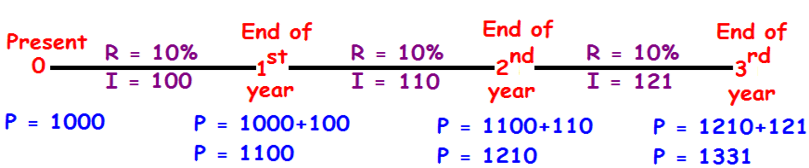
- Compound interest is charged on principle and accumulated interest.
- Compound interest for all years is different.



SIMPLE INTEREST :



COMPOUND INTEREST :



Let P be the principal, R be the interest rate % Per annum, and T be the time period (in years)

Simple Interest :

$$S.I = \frac{P \times R \times T}{100}$$

Compound Interest:

$$C.I = P\left(1 + \frac{R}{100}\right)^{T} - P$$

$$\text{Amount, } A = P\left(1 + \frac{r}{100}\right)^{T}$$

If interest is being compounded n-times a year then $A = P\left(1 + \frac{r/n}{100}\right)^{n*T}$

Difference between Compound Interest and Simple Interest

For Principal = P, Rate of interest per annum = R% = $\frac{R}{100}$

i. Difference between C.I and S.I after 1 year = 0

ii. Difference between C.I and S.I after 2 years = $P\left(\frac{R}{100}\right)^2$

iii. Difference between C.I and S.I after 3 years

$= P\left(\frac{R}{100}\right)^2\left(3 + \frac{R}{100}\right)$

PROFIT & LOSS

i. Keywords

a. Cost Price (CP): Price of an article at which it is bought.

b. Selling Price (SP): Price of an article at which it is sold.

c. Marked Price (MP): It is also known as listed price or printed price or maximum retail price of an article which is decided by the seller so that he can sell it to a customer and make profit.

d. A Profit is earned when selling price of an article is greater than the cost price of the same article. Profit % is calculated on the cost price.

Profit = SP – CP, Profit % = $\left(\frac{SP-CP}{CP}\right)*100 = \left(\frac{Profit}{CP}\right)*100$.

e. A Loss occurs when selling price of an article is lesser than the cost price of the same article. Loss % is also calculated on the cost price.

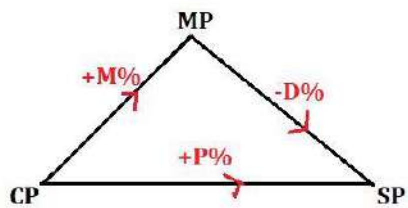
Loss = CP – SP, Loss % = $(\frac{CP-SP}{CP})$*100 = $(\frac{Loss}{CP})$*100.

f. Mark up is the difference between marked price and cost price of an article. Mark up % is also calculated on the cost price.

Mark up value = MP – CP, Mark up % = $(\frac{MP-CP}{CP})$*100

g. Discount is the difference between marked price and selling price. Discount % is calculated on marked price.

Discount = MP – SP, Discount % = $(\frac{MP-SP}{MP})$*100.



If there are two articles, one of them is sold at x% profit and other is sold at x% loss then overall profit OR loss % on overall transaction will be

1. 0, when both articles have same CP.

2. Loss = $\frac{x^2}{100}$ %, when both articles have same SP.

iii. Dishonest Seller & Faulty Measurements

These are cases when a shopkeeper uses lesser weights or measurements than what is promised to the customer while selling goods to get some profit out of it.

In these types of situations,

Profit % = $\frac{\text{Claimed weight} - \text{Actual weight}}{\text{Actual weight}}$*100

E.g. A seller sells 800g for the price of 1000g.

Profit % = (1000-800)/800 x 100 = 25%

iv. Partnerships:

When n number of people invest A_1, A_2, A_3,......., A_n amounts for T_1, T_2, T_3,........, T_n time periods in the same business then profits are shared in the ratio $A_1T_1 : A_2T_2 : A_3T_3$:.............: A_nT_n.

ALLIGATION & MIXTURE

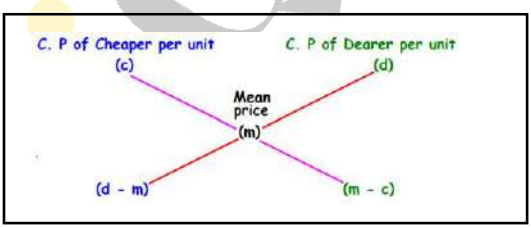
Alligation: The rule allows us to determine the ratio of quantity in which two or more ingredients at the given price must be combined to produce the desired price.

Rule of Alligation:

If two ingredients are mixed, then

$$\frac{\text{Quantity of cheaper}}{\text{Quantity of dearer}} = \frac{\text{C.P. of dearer - Mean Price}}{\text{Mean price - C.P. of cheaper}}$$

Cross proportion representation:



∴ (Cheaper quantity) : (Dearer quantity) = (d - m) : (m - c)

Removal and Replacement

Let us say a container has x units of liquid, and y units are removed and replaced by water.

After n operations, the quantity of the pure liquid = $x\left(1-\frac{y}{x}\right)^n$ units.

- **General formula for n operations:**

$$\text{Final or reduced concentration} = \text{initial concentration}\left(1-\frac{\text{amount being replaced in each operation}}{\text{total amount}}\right)^n$$

- **Weighted Average method:**
  Two mixtures having weights f_1, f_2 and corresponding averages A_1, A_2, their weighted average $A_w = \frac{A_1 * f_1 + A_2 * f_2}{f_1 + f_2}$

iQuanta Building Learning Networks

RATIO & PROPORTION

Properties of ratio:

i. If $0 < \frac{A}{B} < 1$, then $\frac{A}{B} < \frac{A+x}{B+x}$ where $x > 0$.

For example: $\frac{9}{11} < \frac{109}{111}$

Click here!

ii. If $\frac{A}{B} > 1$, then $\frac{A}{B} > \frac{A+x}{B+x}$ where $x > 0$.

For example: $\frac{17}{13} > \frac{57}{53}$

iii. If $\frac{A}{B} = \frac{C}{D} = \frac{E}{F} = \ldots\ldots\ldots = K$ then

a. $\frac{A+C+E+ -----}{B+D+F+ -----} = K$

b. $\frac{pA+qC+rE+ -----}{pB+qD+rF+ -----} = K$

c. $\frac{pA^n+qC^n+rE^n+ ---}{pB^n+qD^n+rF^n+ ---} = K^n$

Note: In points a, b, and c none of the denominators should be equal to zero.

Merging Ratios

Ratios are merged to compare all the quantities at once. Usually, ratios are merged by making the common term equal or multiplying all the ratios together.

E.g. If a : b = 3 : 5 and b : c = 4 : 5 then find a : b : c.

Solution:

Method – 1: firstly, it can be noticed that b is common in both so we can make it equal in both ratios, LCM (4, 5) = 20.
a : b = 3 : 5 = 12 : 20, b : c = 4 : 5 = 20 : 25
Hence, a : b : c = 12 : 20 : 25.

Method – 2:
$\frac{a}{c} = \frac{a}{b} * \frac{b}{c}$
or, $\frac{a}{c} = \frac{3}{5} * \frac{4}{5} = \frac{12}{25}$,
when a = 12, b = 20 and c = 25.
Hence, a : b : c = 12 : 20 : 25.
This method is very useful when there are more than two ratios to be merged.

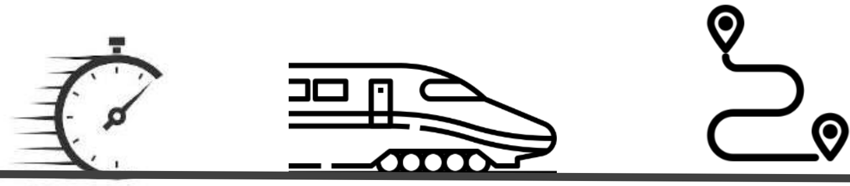
Proportion:

i. If a, b and c are in continued proportion, then $\frac{a}{b} = \frac{b}{c}$ and vice-versa is also true.
Here a is known as the first proportion, b is known as the mean proportion and c is known as the third proportion.

ii. If a, b, c and d are in continued proportion, then $\frac{a}{b} = \frac{c}{d}$ and vice-versa.

iii. If $\frac{a}{b} = \frac{c}{d}$, then $\frac{a+b}{a-b} = \frac{c+d}{c-d}$ which is also known as Componendo & Dividendo.

TIME, SPEED & DISTANCE:



General formula: Distance = Speed × Time

Unit conversion:

Unit of speed = $\frac{\text{km}}{\text{hr}}$

$1\frac{\text{km}}{\text{hr}} = \frac{5}{18}$ m/sec, $1\frac{\text{m}}{\text{sec}} = \frac{18}{5}$ km/hr

Proportionality:

1. When distance is constant: $s \propto \frac{1}{t}$ or $t \propto \frac{1}{s}$ so, st = constant, $s_1t_1 = s_2t_2$

	A		B	P		Q		R
Speed	**3**	**:**	**4**	**3**	**:**	**4**	**:**	**6**
Time	$\frac{1}{3}$	:	$\frac{1}{4}$	$\frac{1}{3}$	:	$\frac{1}{4}$	:	$\frac{1}{6}$
	4	:	3	4	:	3	:	2

Note: If speed is being multiplied by a factor x, then time will be multiplied by $\frac{1}{x}$.

2. When speed is constant: $D \propto t$ or $D_1 : D_2 = t_1 : t_2$

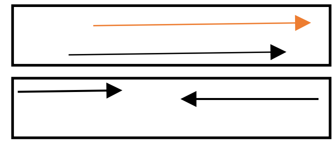
3. When time is constant: $D \propto s$ or $D_1 : D_2 = s_1 : s_2$

Average Speed: Total Distance/Total time taken

iQuanta Building Learning Networks

Relative speed:

The relative speed of two objects moving with speeds S_1 & S_2 when they are moving in:



1. Same direction, $S_R = S_1 - S_2$, $S_1 > S_2$
2. Opposite direction, $S_R = S_1 + S_2$

Special Cases for Trains:

- When a train passes a pole (or, any stationary object of negligible length), it covers a distance which is equal to its own length.
- When a train passes a platform, it covers a distance which is equal to the sum of the length of the platform and its own length.
- When a train A passes a moving train B, it covers a distance which is equal to the sum of the length of both the trains A and B with relative speed.
- When a train A crosses a stationary train B, it covers a distance which is equal to the sum of the length of both the trains.

Special Cases for Boats:

Speed of Boat = B, Speed of river or stream = R (in still water)

Speed in downstream (D) = B + R

Speed in upstream(U) = B - R

In the case of boats and streams, as the distance is constant in upstream and downstream movements, time taken is inversely proportional to the upstream and downstream speeds.

iQuanta Building Learning Networks

LINEAR & CIRCULAR RACES:

Linear races:

1. In a race of d meters A beats B by x metres:

$S_A/S_B = d/(d-x)$

2. In a race, A beats B by t seconds:

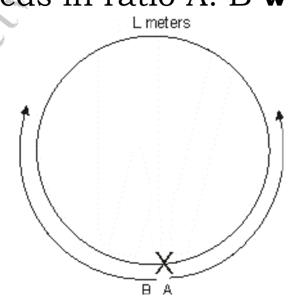
$S_A/S_B = (t_A + t)/t_A$

3. In a race, A beats B by x meters or t sec.

$S_B = \frac{x}{t}$ m/sec

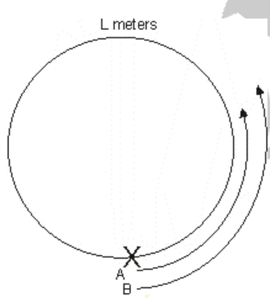
Circular Races:

If two people are running on a circular track with speeds in ratio A: B **where A and B are co-prime**, then



- They will meet at A+B distinct points if they are running in opposite direction.

- They will meet at |A-B| distinct points if they are running in same direction



If two people are running on a circular track having perimeter L, with speeds m and n,

- The time for their first meeting = L/(m +n) (when they are running in opposite directions)

- The time for their first meeting = L/(|m-n|) (when they are running in the same direction)

• Time when 3 objects meet for the first time: Find the time taken for any 2 pairs to meet for the first time and then take the LCM of those times.

• Time when 2 objects meet for the first time at the starting point after moving = LCM (L/m, L/n)

Note: LCM of Fractions LCM (a/b, c/d) = LCM (a, c)/HCF (b, d)

iQuanta Building Learning Networks

TIME & WORK

t – time, e – efficiency, a – amount of work

Case 1: When a is constant, $t \propto \frac{1}{e}$ or $e \propto \frac{1}{t}$
Case 2: When t is constant, $a \propto e$ or $e \propto a$
Case 3: When e is constant $t \propto a$ or $a \propto t$

Wages ∝ amount of work done by worker

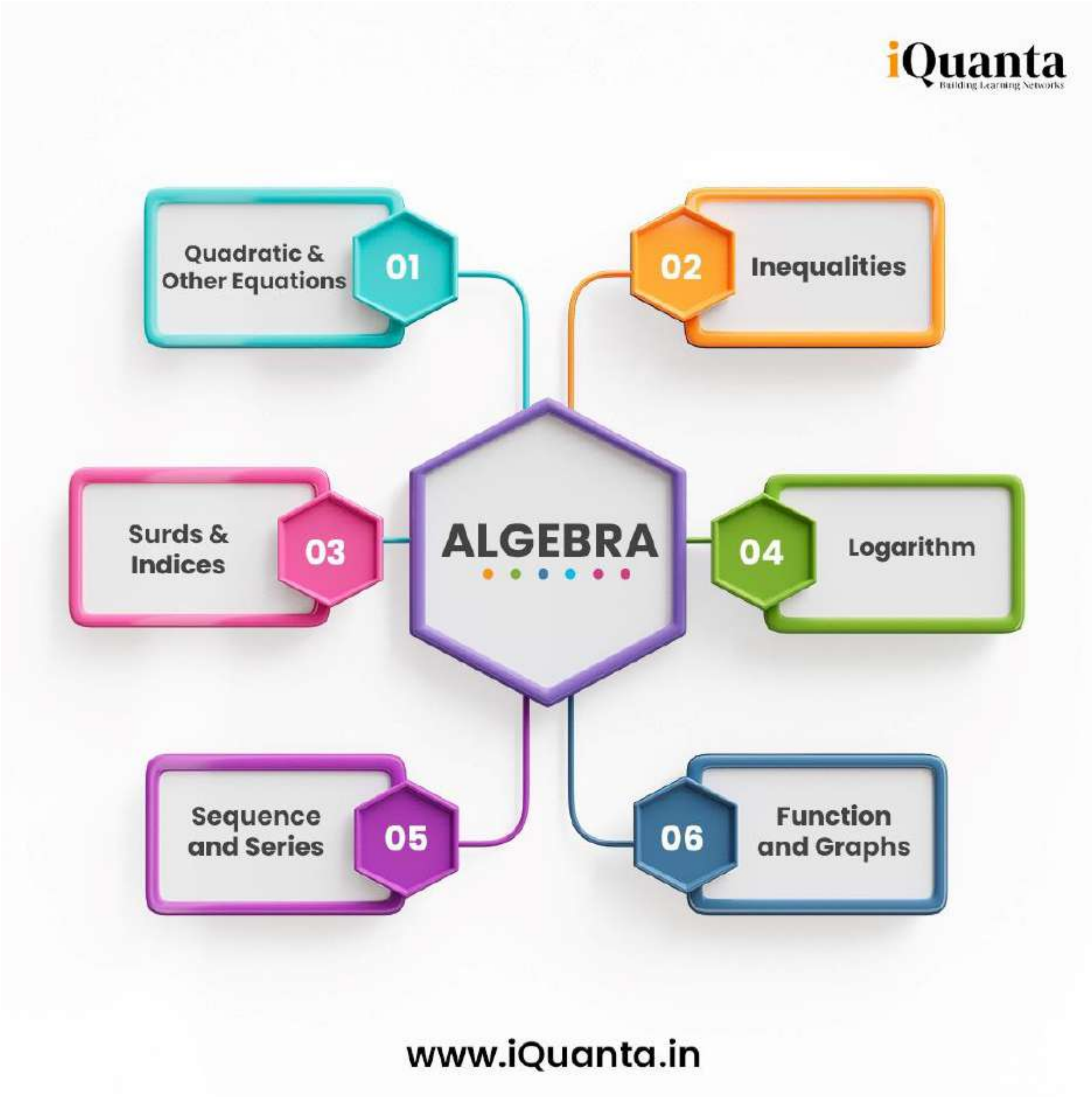
- If A can do a piece of work in n days, then A's 1 day's work = $\frac{1}{n}$
- If A can do a piece of work in x days and B in y days, and together they take z days to complete the work. Then,
  1/z = 1/x + 1/y
  ⇨ $z = \frac{xy}{x+y}$

Concept of Man-days: If M_1 men can do W_1 work in D_1 days working H_1 hours per day and M_2 men can do W_2 work in D_2 days working H_2 hours per day (where all men work at the same rate), then

$$\frac{M1 \times D1 \times H1}{W1} = \frac{M2 \times D2 \times H2}{W2}$$

Points to Remember for Pipe & Cistern questions:

- If we are filling the tank, the Inlet pipes do positive work while the Outlet pipes do negative work.
- If the goal is to empty the tank, the Outlet Pipes do positive work while the Inlet Pipes perform negative work.


iQuanta
Building Learning Networks
Quadratic & Other Equations
01
02
Inequalities
Surds & Indices
03
ALGEBRA
04
Logarithm
Sequence and Series
05
06
Function and Graphs
www.iQuanta.in

QUADRATIC & OTHER EQUATIONS

Some important Algebraic Identities:

- $(a + b)^2 = a^2 + b^2 + 2ab$
- $(a - b)^2 = a^2 + b^2 - 2ab$
- $(a + b + c)^2 = a^2 + b^2 + c^2 + 2\ (ab + bc + ca)$
- $(a + b)^3 = a^3 + b^3 + 3ab\ (a + b)$
- $(a - b)^3 = a^3 - b^3 - 3ab\ (a - b)$
- $a^3 + b^3 = (a + b)\ (a^2 - ab + b^2)$
- $a^3 - b^3 = (a - b)\ (a^2 + ab + b^2)$
- $a^2 - b^2 = (a + b)\ (a - b)$
- $(a + b + c)^3 = a^3 + b^3 + c^3 + 3(a + b)\ (b + c)\ (c + a)$
- $a^3 + b^3 + c^3 - 3abc = (a + b + c)\ (a^2 + b^2 + c^2 - ab - bc - ca)$

  If $a + b + c = 0$, then $a^3 + b^3 + c^3 = 3abc$

A quadratic equation is represented as

$$\mathbf{ax^2 + bx + c = 0}$$ **(if a = 0, then equation becomes linear)**

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

All values of 'x' satisfying the eqaution are known as roots/zeroes of the equation.

Note: An equation of degree **'n'** will have n roots (real and imiginary) (E.g. Cubic equation has 3 roots)

- If c' and 'a' are equal then the roots are reciprocal to each other.

iQuanta Building Learning Networks

- A quadratic whose roots are reciprocal of the roots of $ax^2+bx+c = 0$ is $cx^2+bx+a = 0$
- If b = 0, then the roots are equal and are opposite in sign
- **Discriminant :**

It is denoted by **D**, and $\mathbf{D = b^2 - 4ac}$. Depending on the sign and value of D, nature of the roots would be as follows:

- If $\mathbf{D < 0}$, Roots will be imaginary. The graph would not touch x axis.
- If $\mathbf{D > 0}$, Roots will be real and distinct. Graph cuts X axis at two distinct points.
- If $\mathbf{D = 0}$, Roots are real and equal. Graph just touches the x axis at one point.

<u>**Note:**</u> Complex or irrational roots always occur in pair i.e., they are conjugate. E.g.: $x^2 - 4x - 1 = 0$
$x = (2 \pm \sqrt{5})$ i.e., roots are $2 + \sqrt{5}$ and $2 - \sqrt{5}$ which are conjugate pairs.

	Quadratic Equation $ax^2 + bx + c = 0$	**Cubic Equation** $ax^3 + bx^2 + cx + d = 0$
Sum of roots	$\alpha + \beta = -b/a$	$\alpha + \beta + \gamma = -b/a$
Product of roots	$\alpha\beta = c/a$	$\alpha\beta\gamma = -d/a$
Pairwise sum of Product of roots	-	$\alpha\beta + \beta\gamma + \lambda\alpha = c/a$
A quadratic eq. can be written as $x^2 - Sx + P = 0$ where S = sum of roots and P = product of roots		

- For any given equation $y = f(x) = 0$ the number of times the graph of this equation cuts the X axis is equal to the distinct real roots of this equation. For Exp: $(x-1)(x+2)(x-2) = 0$ will intersect x axis at 3 distinct points: 1, -2, 2
- Any quadratic equation will be of the form $(x-a)(x-b) = 0$ and will cut the axis at a and b.

- When a > 0, $ax^2 + bx + c$ has minimum at $x = -b/2a$ & that minimum is $-D/4a = (4ac-b^2)/4a$
- When a < 0, $ax^2 + bx + c$ has maximum at $x = -b/2a$ & that maximum is $-D/4a = (4ac-b^2)/4a$

INEQUALITIES

If Roots are Real,

- when (x-a) (x-b) > 0
  $x \in (-\infty, a) \cup (b, \infty)$

- when (x-a) (x-b) < 0
  $x \in (a, b)$

Note:

- If product of n positive numbers is constant, then their sum will be minimum when all are equal or close to each other.

- If the sum of n positive numbers is constant, then their product will be maximum when all are equal or close to each other.

- In case of equations, for example 3x = 5y, multiplying with -1 on both sides results in -3x = -5y.
  But in the case of inequalities, for example 3x > 5y, on multiplying with -1 on both sides, the inequality changes to -3x < -5y
  For example 7 > 4, but -7 < -4.

- In inequalities, one cannot cancel the common multiple on both sides. For example, cancelling the common multiple 'x' in x(x-1) > x(y-2) is not allowed.

SURDS & INDICES

Important points to remember:

- In surd questions, every surd is an irrational number.
  Ex: $\sqrt{4}$, $\sqrt[2]{5}\sqrt[3]{7}$

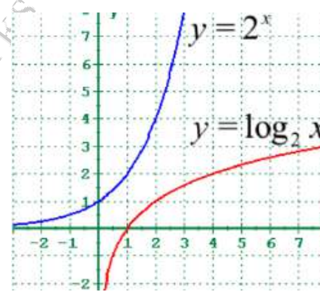
- Any integer raised to the power zero will always equal one.

Law of surds	Law of indices
$\sqrt{m \times n} = \sqrt{m} \times \sqrt{n}$	$a^n \cdot a^m = a^{m+n}$
	$a^n \cdot b^n = (a \cdot b)^n$
$\sqrt{\frac{m}{n}} = \frac{\sqrt{m}}{\sqrt{n}}$	$a^m / a^n = a^{m-n}$
	$a^n / b^n = (a / b)^n$
$\frac{r}{\sqrt{s}} = \frac{r}{\sqrt{s}} \times \frac{\sqrt{s}}{\sqrt{s}} = \frac{r\sqrt{s}}{s}$ $p\sqrt{q} \pm r\sqrt{q} = \sqrt{q}(p \pm r)$ $\frac{r}{p \pm q\sqrt{n}}$: Multiply num and den by $p \mp q\sqrt{n}$ to rationalise the denominator	$(a^n)^m = a^{n \cdot m}$
	$a^{n^m} = a^{(n\hat{}m)}$
	$^{m}\sqrt{(a^n)} = a^{n/m}$
	$^{n}\sqrt{a} = a^{1/n}$
	$a^{-n} = 1 / a^n$

LOGARITHMS

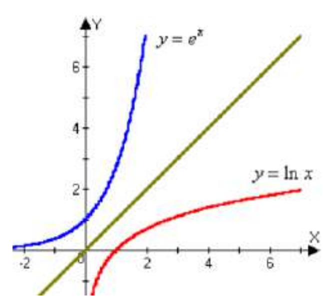
- $a^x = N$ can be expressed in logarithmic form as $x = \log_a N$
  $\log a = x$ means that $a = 10^x$
- **Natural Logarithm:** $\log_e N$ is called Natural logarithm, denoted by ln N i.e., when the base is **'e'** then it is called as Natural logarithm.
- **Common Logarithm**: $\log_{10}$ **N** is called **common logarithm** i.e., when base of log is 10, then it is called as common logarithm.
- **Both functions are graphed below: Base of 2 and base of e**

Logarithm Properties:



- $\log (mn) = \log m + \log n,\ m > 0,\ n > 0$ **(Addition)**
- $\log \left(\frac{m}{n}\right) = \log m - \log n,\ m > 0,\ n > 0$ **(Subtraction)**
- $\log m^n = n (\log m)$ **(Logarithm of a power)**
- $\log_x y = \frac{\log_a y}{\log_a x}$ **(Change of base rule)**
- $\log_x y = \frac{1}{\log_y x}$ **(Inverse)**
- $\log_x 1 = 0\ (x \neq 0, 1)$.

  Note: The logarithm of "0" and negative numbers is not defined.
-
- $\log_b 1 = 0\ (\because b^0 = 1)$
- $\log_b b = 1\ (\because b^1 = b)$
- $y = \ln x \rightarrow x = e^y$
- $x = e^y = \rightarrow \ln x = y$
- $x = \ln e^x = e^{\ln x}$
- $\mathbf{\log_b b^y = y}$



SEQUENCES, SERIES & PROGRESSIONS

Arithmetic Progression (A.P)

An A.P. is of the form a, a+d, a+2d, a+3d, ... where a is called the 'first term' and d is called the 'common difference'.

n^{th} term of an A.P: $T_n = n^{th}$ term $= a + (n - 1)\, d$

(d = common difference, n = numbers of terms)

Sum of the first n term of an A. P: $S_n = \frac{n}{2}[2a + (n - 1)d] = \frac{n}{2}[a + L]$

(L = last term, a = first term)

Arithmetic Mean (A.M): A.M $= \frac{1}{2}$(Sum of all terms) $= \frac{1}{2}$(first term + last term)

Geometric Progression (G.P)

A G.P. is of the form a, ar, ar^2, ar^3, ... where a is called the 'first term' and r is called the 'common ratio'.

nth term of a G.P: $T_n = a\, r^{\,n-1}$

Sum of the first n terms in a G.P: $S_n = \frac{a|1-r^n|}{|1-r|}$; Sum of ∞ terms: $S_\infty = \frac{a}{|1-r|}$

Geometric Mean (G.M): $b = \sqrt{ac}$

(a, b, c are the 3 consecutive terms of a GP)

Harmonic Progression (H.P.)

If the reciprocals of the terms of a sequence are in arithmetic progression, the sequence is called harmonic progression.

iQuanta Building Learning Networks

For E.g. $1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4} \ldots$ is in harmonic progression. If we write it in form of H.P i.e., $\frac{1}{a}, \frac{1}{a+d}, \frac{1}{a+2d}, \ldots$

Harmonic Mean (H.M) of x, y = $\frac{2xy}{x+y}$

For any two positive number a and b, A.M ≥ G.M ≥ H.M

Some useful results:

- Sum of first n natural numbers = $\frac{n(n+1)}{2}$
- Sum of the squares of first n natural numbers = $\frac{n(n+1)(2n+1)}{6}$
- Sum of the cubes of first n natural nos. = $\left[\frac{n(n+1)}{2}\right]^2$
- Sum of first n natural odd numbers = n^2
- Sum of first n even numbers = n(n+1)

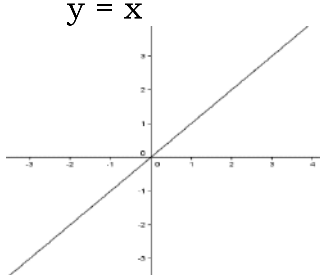
FUNCTIONS & GRAPHS

A function is a special relationship where each input has a single output (but 2 different inputs can have the same output). It is often written as "y = f(x)" where x is the input value in the function y.

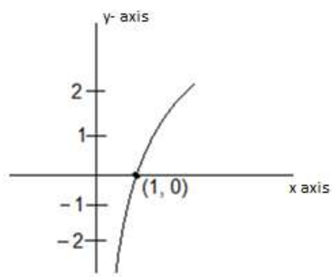
Domain: Set of real and finite values that x can take.
Range: Set of real and finite values that y can have corresponding to the values of x.
Note: Set A has m elements & set B has n elements then no. of functions possible from set A to set B = n^m

Some important graphs:

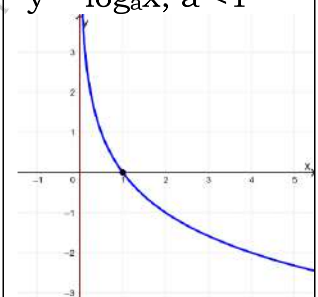
$y = x$



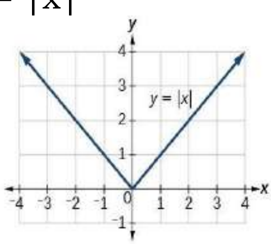
$y = \log_a x$, $a > 1$



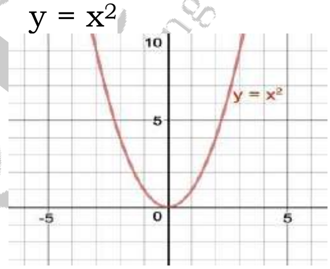
$y = \log_a x$, $a < 1$



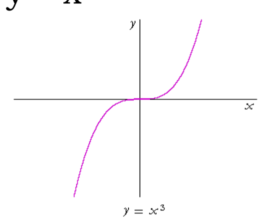
$Y = |x|$



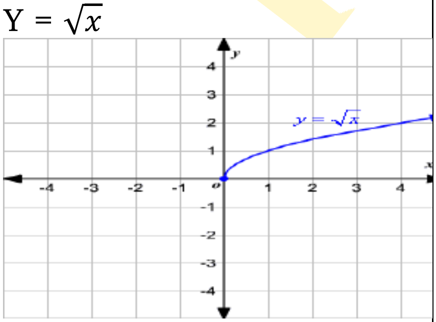
$y = x^2$



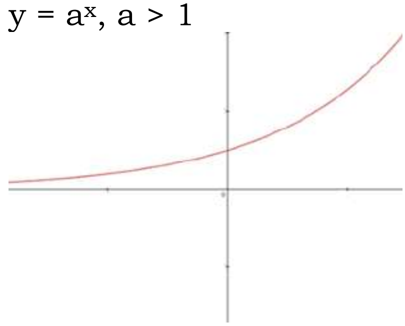
$y = x^3$



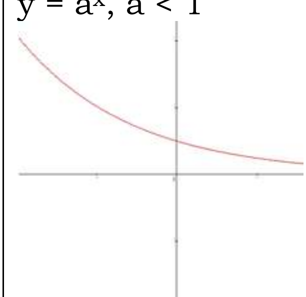
$Y = \sqrt{x}$

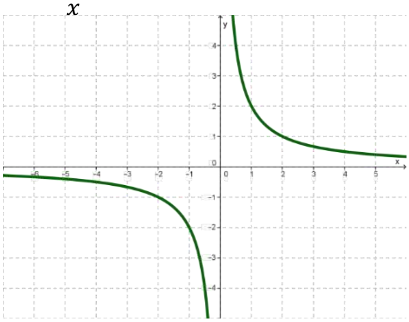
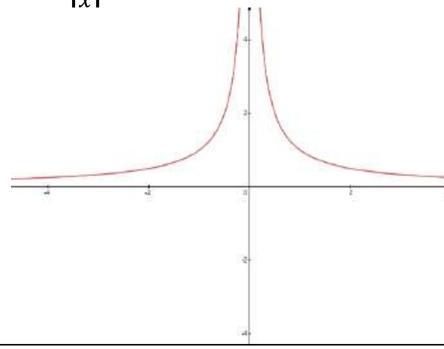


$y = a^x$, $a > 1$



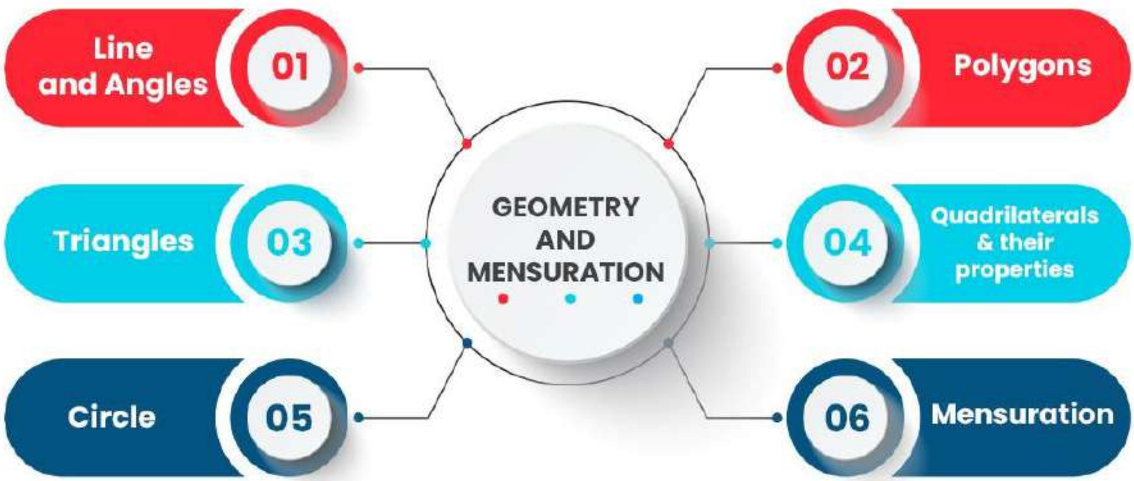
$y = a^x$, $a < 1$



$Y = \frac{1}{x}$ 	$y = \left\lvert\frac{1}{x}\right\rvert$ 	

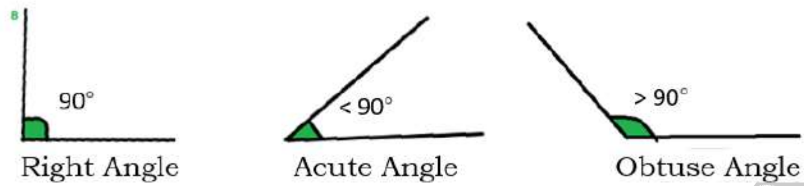
iQuanta Building Learning Networks

iQuanta
Building Learning Networks



www.iQuanta.in

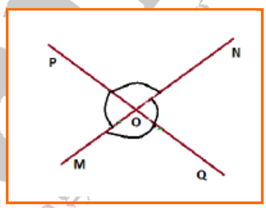
GEOMETRY



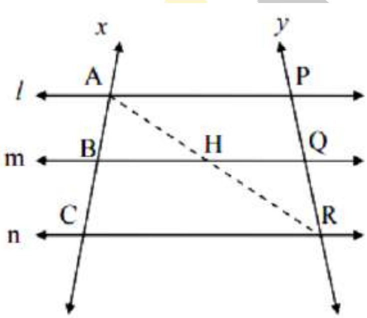
Complementary & Supplementary Angles:
Two angles which add up to 90 degrees are called complementary angles and two angles which add up to 180 degrees are called supplementary angles.

Vertically Opposite Angles:

$\angle POM = \angle NOQ \;\&\; \angle PON = \angle MOQ$



Point to be remember:
The ratio of intercepts formed by a transversal intersecting three parallel lines is the same as the ratio of intercepts formed by any other transversal.



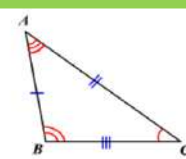
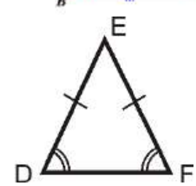
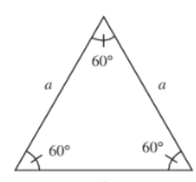
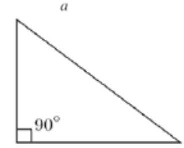
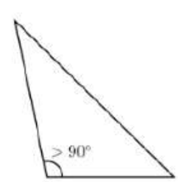
$$i.e., \quad \frac{AB}{BC} = \frac{PQ}{QR}$$

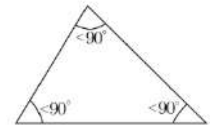
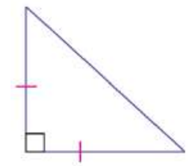
Polygons:

Straight sided, 2-D shapes that close in a space are known as polygons.

- Number of diagonals in an n-sided polygon = $\frac{n(n-3)}{2}$
- Sum of all the exterior angles of any polygon = **360°**
- Measure of each exterior angle of a regular polygon = $\frac{360°}{n}$
- Sum of all interior angles of any polygon = **(n-2) x 180⁰**
- Measure of each interior angle in a regular polygon= $\frac{(n-2)180^0}{n}$

Triangle:

Type of triangles	Characteristics	Figure
Scalene Triangle	A triangle with sides of differing lengths.	
Isosceles Triangle	Is one with two sides that have the same length.	
Equilateral Triangle	A triangle with all sides of equal length	
Right-angled Triangle	One angle of 90°	
Obtuse-angled Triangle	One of the angles of the triangle is more than 90°	

Acute-angled Triangle	All the angles of the triangle are less than 90°	
Isosceles Right-angled Triangle	A right-angled triangle, whose two sides containing the right angle are equal in length.	

Pythagoras Theorem:
Pythagoras theorem is applicable in the case of a right-angled triangle. It says that the square of the hypotenuse is equal to the sum of the squares of the other two sides.

$$\textbf{Hypotenuse}^2 = \textbf{Base}^2 + \textbf{Perpendicular}^2$$

Properties of a triangle:
- The sum of all the angles of a triangle = 180° ($\angle a + \angle b + \angle c = 180$)
- The sum of lengths of any two sides > length of the third side
- The difference of any two sides of any triangle < length of the third side

The area of any triangle formula:

$$\text{Area} = \frac{1}{2} \times \text{base} \times \text{height} = r \times s = (a \times b \times c)/4R = \frac{1}{2} \times a \times b \times \sin C$$

where a, b and c are the sides of the triangle, r is the inradius, R is circumradius, and s is the semi perimeter.

By Heron's formula, the area of the triangle is given by:

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

where 's' is the semi perimeter

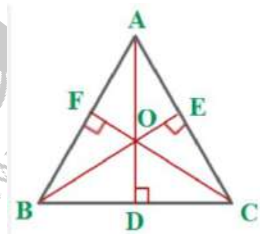
$$s = \frac{a+b+c}{2}$$

Some important Definitions:

Altitude of Triangle: Perpendicular drawn from a vertex of a triangle to the side opposite side.

Median of triangle: The straight lines drawn from the vertex of triangle that bisect the opposite sides of the triangles is called median of a triangle.

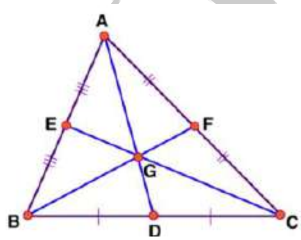
Orthocentre: The point inside a triangle where the altitudes meet is called orthocentre of the triangle.



AD, BE and EF are altitudes of the triangle and O is the orthocentre of the triangle.

Circumcentre: The point inside a triangle where the perpendicular bisectors of each side meet.

Centroid: The place/point where all the medians meet is called centroid of the triangle. The Centroid divides each median in the ratio 2: 1.

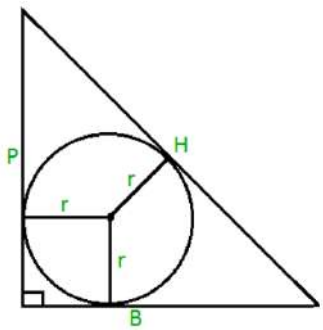


AD, BF, CE – medians of ΔABC.
G is the centroid of the Δ.
AG: GD = 2: 1
CG: GE = 2: 1
BG: GF = 2: 1

Centroid divides the line joining the circumcentre & orthocentre in ratio 2:1.

Incentre: The point inside a triangle where the angle bisectors meet.

Note: All the above points are same in case of Equilateral triangle.

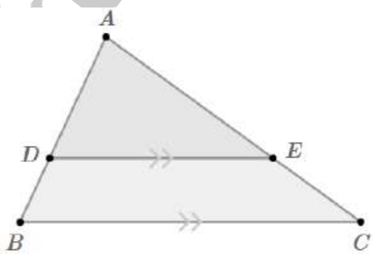


Right angle triangle:

Circumradius = $\frac{H}{2}$

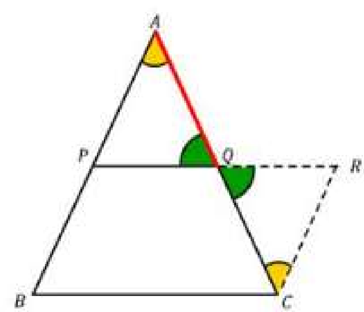
Inradius (r) $= \frac{P+B-H}{2}$

Important Theorems for Triangles



Basic Proportionality Theorem (BPT):
Any line parallel to one side of a triangle divides the other two sides proportionally. So, if DE is drawn parallel to BC, then it would divide sides AB and AC proportionally.

i.e., AD/DB = AE/EC



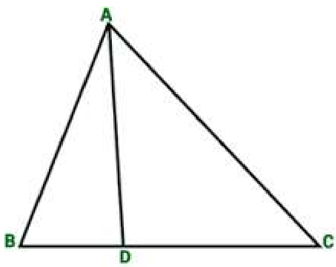
Mid-point theorem: The line segment joining mid-points of two sides of a triangle is parallel to the third side of the triangle and is half of it.

P and Q are the mid points of AB and AC respectively.
PQ || BC & PQ = BC/2

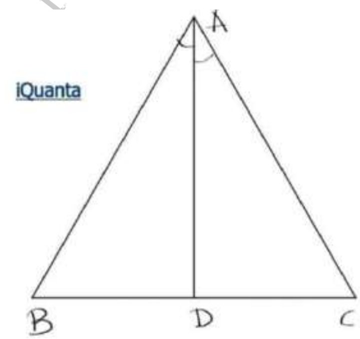
Apollonius' theorem: In a triangle, the sum of the squares of any two sides of a triangle is equal to twice the sum of the square of the median to the third side and square of half the third side.

$AB^2 + AC^2 = 2(AD^2 + BD^2)$

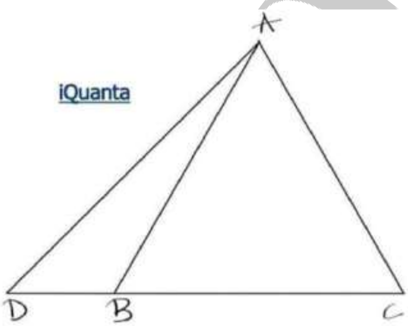
(AD is median)



Interior angle Bisector theorem: In a triangle, the angle bisector of an angle divides the opposite side to the angle in the ratio of the remaining two sides.



AB/BD = AC/CD



AD being the exterior angle bisector of angle A

=> DC/DB = AC/AB

Exterior angle Bisector theorem: In a triangle, the angle bisector of any exterior angle of a triangle divides the side opposite to the external angle in the ratio of the remaining two sides

Similarity of Triangles:

- AA similarity (angle – angle)
- SSS similarity (side – side – side)
- SAS similarity (side – angle – side)

Types of Quadrilaterals

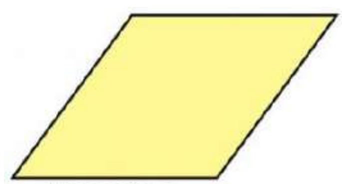
Quad = four. So, quadrilaterals are polygons with 4 sides.
Square & Rectangle are the most basic quadrilaterals.

Parallelogram: A parallelogram is a quadrilateral when its opposite sides are equal and parallel. The diagonals of a parallelogram bisect each other.

Perimeter = 2 × sum of adjacent sides
Area = b × h
(b – width, h – length of perpendicular)

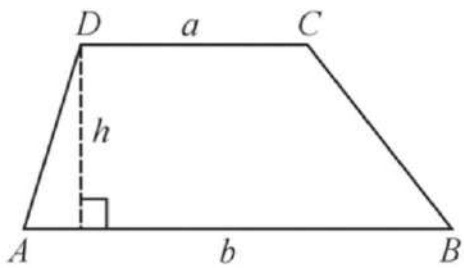
Rhombus: A rhombus is a quadrilateral when all sides are equal. The diagonals of a rhombus bisect each other at right angles (90°)

Perimeter = 4 × Side
Area = $\frac{1}{2} \times d_1 \times d_2$
(d_1 and d_2 are diagonals)



Trapezium: A trapezium is a quadrilateral in which only one pair of the opposite sides is parallel.

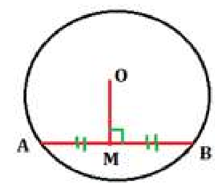
Area = ½ × (a + b) × h
Perimeter = Sum of all four sides



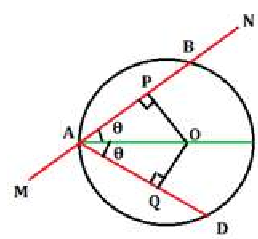
CIRCLE:

Area = Πr^2
Perimeter = $2\Pi r = \Pi d$ (as we know $d = 2r$)

Properties of circles:



1. ⊥ bisector of any chord always passes through centre & vice – versa is also true.

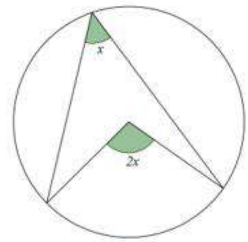


2. If the ⊥ distances from the centre are equal then chords are equal
If OP = OQ, then AB + AD

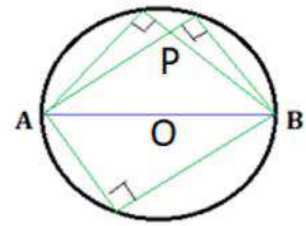
(MN = secant, AB & AD are chords. Arc AB = minor arc, Arc ADB = major arc.)

3. The angle bisector of two equal chords always passes through the centre.

4. The angle at the center of a circle is twice the angle at the circumference.

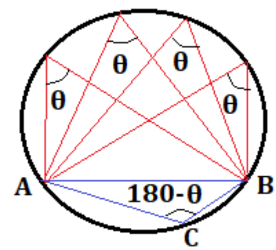


a) So, angle made by the diameter on the circumference = $180^0/2 = 90^0$



b) Angle made by a chord in the major arc is & in minor arc is obtuse & these angles are supplementary.

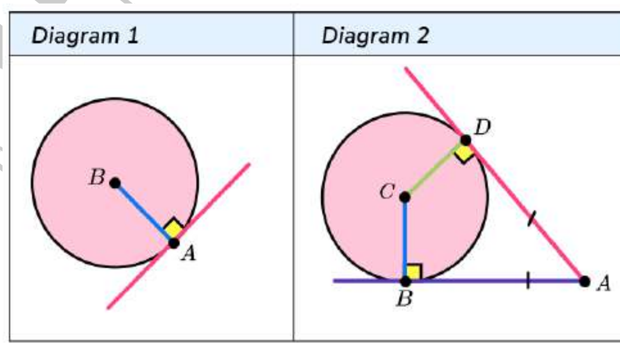
c) Angles made by a chord or chords of equal lengths on the circumference are equal.

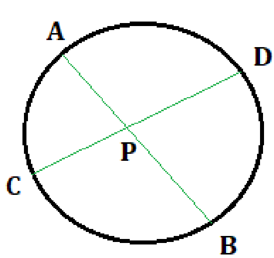


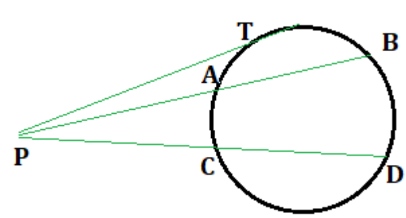
Tangent of circle: A straight line that touches the circumference of the circle at only one point.

- The angle between a tangent and radius is 90 degrees.

- Tangents drawn by a point on circle are always equal. AB = AD





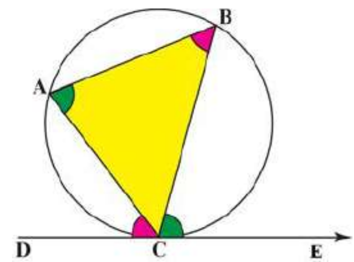


$PA \times PB = PC \times PD$

$PT^2 = PA \times PB$ (where PT is a tangent)

Alternate segment theorem:

For any circle, the angle formed between the tangent and the chord through the point of contact of the tangent is equal to the angle formed by the chord in the alternate segment



Mensuration:

Cube:

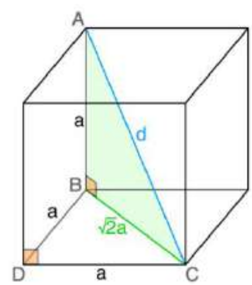
$V = a^3$

L.S.A = $4a^2$

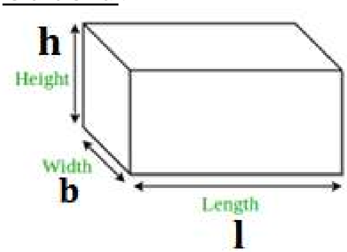
T.S.A = $6a^2$

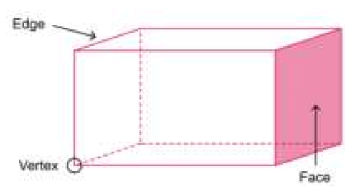
Length of each face diagonal $= a\sqrt{2}$

Length of body diagonal = $a\sqrt{3}$



Cuboid:





V = l.b.h

LSA = 2 (lh + bh) = 2h (l + b)

TSA = 2 (lb + bh + hl)

Lengths of face diagonals are $\sqrt{l^2 + b^2}$, $\sqrt{l^2 + h^2}$, $\sqrt{b^2 + h^2}$

Length of body diagonal = $\sqrt{l^2 + b^2 + h^2}$

Sphere:

Volume = $\frac{4}{3}\pi r^3$

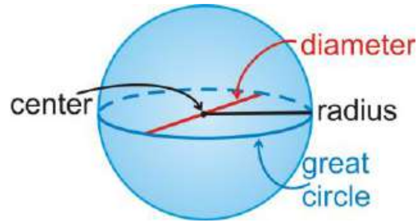
Total surface area = $4\pi r^2$

Hemisphere:

Volume = $\frac{2}{3}\pi r^3$

C.S.A = $2\pi r^2$

T.S.A = $3\pi r^2$

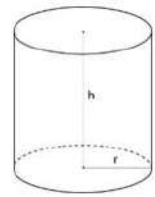


Cylinder:

V = $\Pi r^2 h$

LSA = $2\pi rh$

TSA = $2\pi r^2 + 2\pi rh = 2\pi r(r + h)$



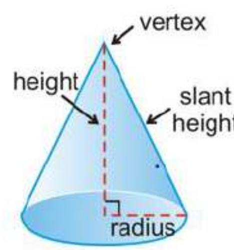
Cone:

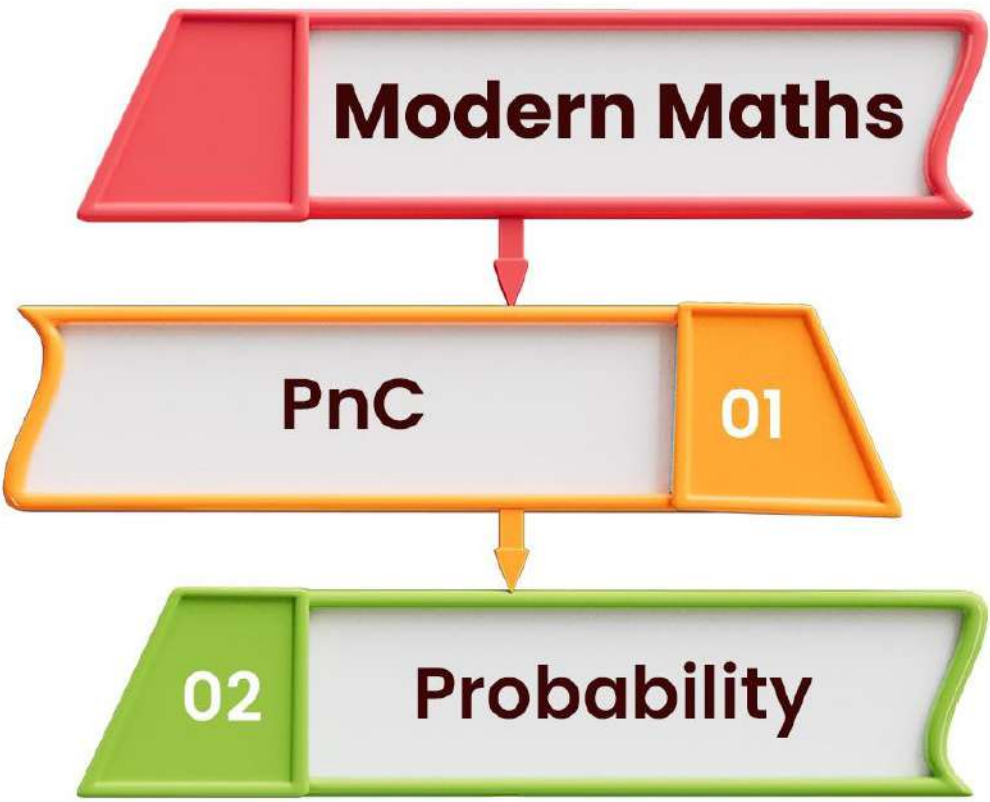
Volume = $\frac{1}{3}\pi r^2 h$

LSA = πrl

TSA = $\pi r^2 + \pi r(r + l)$

Slant height = $\sqrt{r^2 + h^2}$





www.iQuanta.in

PERMUTATION & COMBINATION

P&C Basics:

When two tasks are performed in succession, i.e., they are connected by an 'AND', to find the total number of ways of performing the two tasks, you must MULTIPLY the individual number of ways.
When only one of the two tasks is performed, i.e., the tasks are connected by an 'OR', to find the total number of ways of performing the two tasks you must ADD the individual number of ways.

- **Arrangement:** n items can be arranged in n! ways
- **Permutation**: A way of selecting and arranging r objects out of a set of n objects. Denoted as $^nP_r = n!/(n-r)!$

- **Combination:** A way of selecting r objects out of n (arrangement does not matter) $\mathbf{^nC_r = \frac{n!}{(n-r)!r!}}$

- Number of ways of selecting r things out of n distinct things is $^nC_r = {^nC_{n-r}}$

- No. of ways of choosing any number of things out of n distinct things is 2^n

- No. of ways of choosing any number of things out of n identical things is n+1

- No. of ways of distributing n identical things among r distinct groups such that all may get any number of things is $^{(n+r-1)}C_{(r-1)}$
- No. of ways of distributing n identical things among r distinct groups such that all get at least 1 is $^{(n-1)}C_{(r-1)}$

- No. of ways of distributing n distinct things among r distinct groups is r^n

- If x items out of n items are repeated, then the number of ways of arranging these n items is n!/x! ways. If a items, b items and c items are repeated within n items, they can be arranged in $\left(\frac{n!}{a!b!c!}\right)$ ways.

▪ **Derangement:** If n distinct items are arranged, the number of ways they can be arranged so that they do not occupy their intended spot is

$$D = n!\left(\frac{1}{0!} - \frac{1}{1!} + \frac{1}{2!} - \frac{1}{3!} + \cdots \ldots \frac{(-1)^n}{n!}\right)$$

▪ **Circular arrangement of 'n' distinct items:** Fix the first item and then arrange all the other items linearly with respect to the first item. This can be done in (n-1)! ways.

Note: In a necklace, it can be done in $\frac{(n-1)!}{2}$ **ways.**

PROBABILITY

Probability is nothing but determining the chance, that event might occur. It is denoted by P (E), where P is probability and E is the event.

$0 \leq P(E) \leq 1$ by definition

$$\text{Probability of event occurring} = \frac{\text{Number of favourable outcomes}}{\text{Total no.of outcomes}}$$

E.g. The **sample space** for the tossing of three coins simultaneously is given by:

S = {(T , T , T) , (T , T , H) , (T , H , T) , (T , H , H) , (H , T , T) , (H , T , H) , (H , H, T) ,(H , H , H)}

Total outcomes = 2 x 2 x 2 = 8 since each coin can have 2 outcomes.