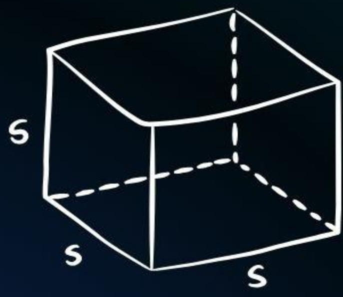
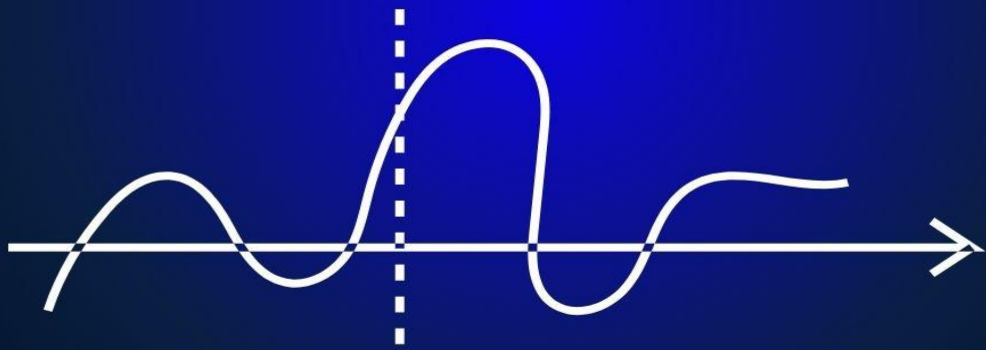
National higher school of mathematics

$$M = \left(\frac{x_1 + x_2}{2} , \frac{y_1 + y_2}{2} \right)$$



$$V = s^3$$

Dictionary for mathematics students



$$f(x)$$

$$m = \frac{\Delta y}{\Delta x}$$

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

$$V = \frac{4}{3} \pi r^3 \quad ax^2 + bx + c = 0$$

NATIONAL HIGHER SCHOOL OF MATHEMATICS

DICTIONARY

DICTIONARY FOR MATHEMATIC STUDENTS

A BRIEF DICTIONARY FOR THE FIRST YEAR STUDENTS WHO STRUGGLE WITH ENGLISH

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Resources :

- *britannica.com*
- *vocabulary.com*
- *mathworld.wolfram.com*
- *math.stackexchange.com*
- *en.wikipedia.com*
- *collinsdictionary.com*
- *merriam-webster.com*

"Young man, in mathematics you don't understand things

You just get used to them."

- John von Neumann

Introduction :

Language is both a bridge and a barrier in education. For first-year students, mastering English can often feel like an uphill battle, especially when grappling with abstract concepts and dense course materials. This dictionary is the culmination of the hard work and dedication of first-year students who understand these challenges firsthand. Our goal is to provide a practical tool to help students overcome linguistic obstacles and gain clarity in their studies.

We recognize that understanding lessons and completing tasks often hinges on grasping the key terms and words central to the subject matter. While definitions are readily available in course materials, it is the mastery of these keywords that truly unlocks comprehension. This is especially true in fields like statistics, where precise terminology underpins the ability to understand and apply complex ideas. Consequently, rather than reiterating textbook definitions, we have focused on providing concise explanations of critical terms that support students in deciphering definitions and navigating lessons.

Our approach is informed by a belief that learning is most effective when tools are tailored to the actual needs of learners. This dictionary has been carefully curated to prioritize accessibility, relevance, and clarity. It is not merely a reference but a companion to guide students through their academic journey, empowering them to approach their studies with confidence and competence.

In addition to serving as a resource for key terms, we hope this dictionary fosters a deeper appreciation of the English language as an essential tool for academic and personal growth. By addressing the unique struggles faced by students, we aim to create a resource that is not only practical but also a testament to the collaborative spirit and resilience of first-year learners.

INDEX

Physics

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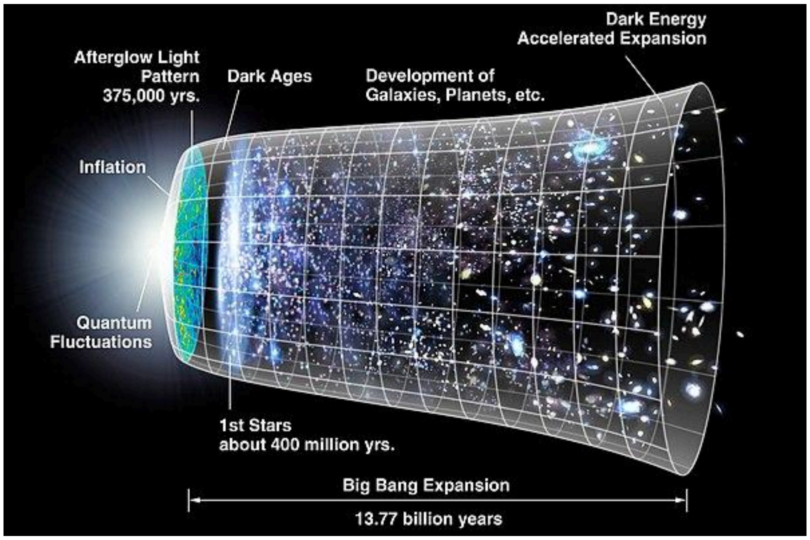


Physics is the scientific study of matter, its fundamental constituents, its motion and behavior through space and time, and the related entities of energy and force. Physics is one of the most fundamental scientific disciplines.

A scientist who specializes in the field of physics is called a physicist.

Physics is one of the oldest academic disciplines. Over much of the past two millennia, physics, chemistry, biology, and certain branches of mathematics were a part of natural philosophy, but during the Scientific Revolution in the 17th century, these natural sciences branched into separate research endeavors. Physics intersects with many interdisciplinary areas of research, such as biophysics and quantum chemistry, and the boundaries of physics are not rigidly defined. New ideas in physics often explain the fundamental mechanisms studied by other sciences[2] and suggest new avenues of research in these and other academic disciplines such as mathematics and philosophy.

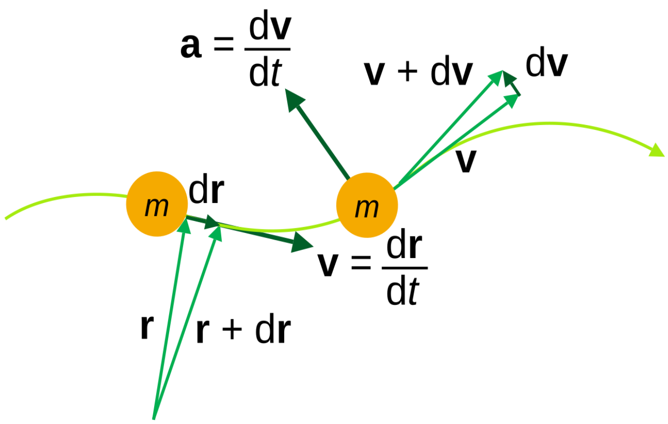
1. **Acceleration** : is the rate of change of velocity of an object. It is measured in meters per second squared (m/s^2).

Examples:

A car speeding up from 0 to 60 km/h in 10 seconds.

A ball rolling faster as it goes down a slope.

2. **Acceleration Motion:** Motion in which an object's velocity increases over time.



This occurs when an object gains speed in a particular direction, associated with positive acceleration.

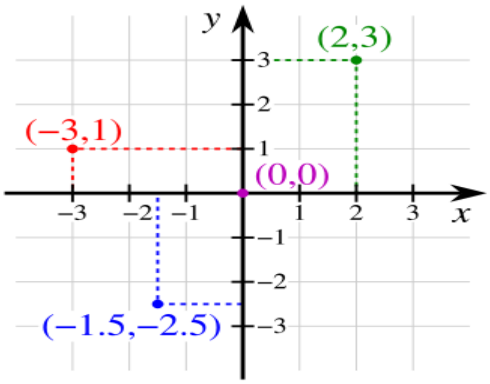
Example:

A car speeding up from 0 to 60 km/h in 10 seconds is experiencing acceleration motion.

3. **Angular acceleration**: (symbol α, alpha) is the time rate of change of angular velocity. Following the two types of angular velocity, spin angular velocity and orbital angular velocity, the respective types of angular acceleration are: spin angular acceleration, involving a rigid body about an axis of rotation intersecting the body's centroid; and orbital angular acceleration, involving a point particle and an external axis.
4. **Angular displacement (symbol θ, ϑ, or φ)** – also called angle of rotation, rotational displacement, or rotary displacement – of a physical body: is the angle (in units of radians, degrees, turns, etc.) through which the body rotates (revolves or spins) around a centre or axis of rotation.
5. **Angular velocity (symbol ω)** :the lowercase Greek letter omega), also known as angular frequency vector, is a pseudovector representation of how the angular

position or orientation of an object changes with time, i.e. how quickly an object rotates (spins or revolves) around an axis of rotation and how fast the axis itself changes direction.

6. **average speed** : is defined as the total distance covered divided by the time interval. Example:if a distance of 80 kilometres is driven in 1 hour, the average speed is 80 kilometres per hour.
7. **Average velocity** :of an object over a period of time is its change in position, divided by the duration of the period.
8. **Cartesian Coordinate System**: A system that uses perpendicular axes (x, y, and z) to define a point in space.



Example:

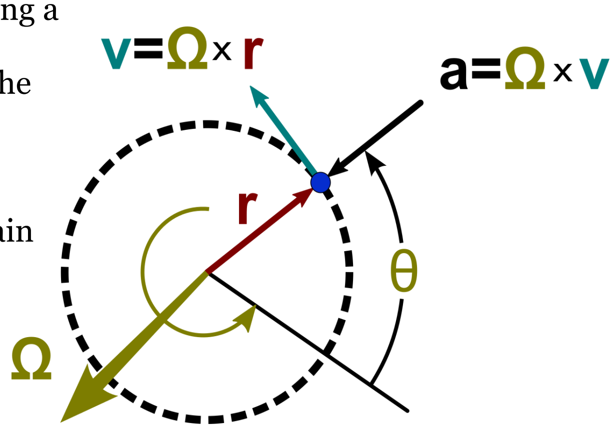
A car's position at (3, 4) in a 2D Cartesian system means it is 3 units along the x-axis and 4 units along the y-axis.

9. **Centripetal Force**: is the force that keeps an object moving in a circular path, always directed toward the center of the circle.

Example:

A car turning in a circular track.A ball tied to a string being swung in a circle.

10. **Circular Motion:** The motion of an object along a circular path. The object's distance from the center of the circle remains constant, but its direction continuously changes, requiring a force (centripetal force) to maintain the motion.



Example:

A satellite orbiting the Earth moves in a circular path.

Its speed might remain constant, but the direction of its velocity continuously changes due to Earth's gravity acting as the centripetal force.

11. **Conservation of Energy** : Energy cannot be created or destroyed, only transformed from one form to another.

Example:

A pendulum converting potential energy into kinetic energy and back.

A car engine converting chemical energy into mechanical energy.

12. **Conservation of Momentum :** This principle states that the total momentum of a closed system remains constant if no external forces act on it.

Examples:

Two billiard balls colliding and moving apart.

A rocket launching as gases are expelled downward.

13. **Coordinate:** A value or set of values that
14. specifies the position of a point or object in a
15. defined reference frame.

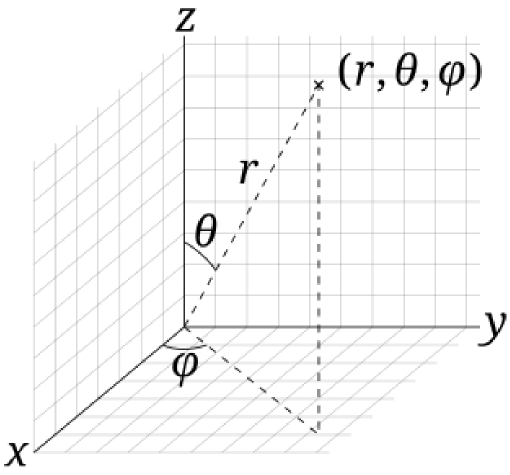
Coordinates are used to describe an object's location

in space.

Types of Coordinate Systems:

Cartesian, polar, cylindrical, and spherical systems are

commonly used.



16. **Deceleration Motion:** Motion in which an object's velocity decreases over time.

This occurs when an object slows down, resulting in negative acceleration.

Example:

A car slowing down from 60 km/h to a stop at a traffic light is experiencing deceleration motion.

17. **Displacement:** The distance between an object's initial and final position in a given time interval.
18. **Distance :** The total path traveled by an object. It is a scalar quantity.
19. **Efficiency:** The ratio of useful energy output to total energy input, usually expressed as a percentage.
20. **Elastic Collision** : An elastic collision is one where objects collide and bounce off without losing kinetic energy.

Examples:

Two rubber balls bouncing off each other.

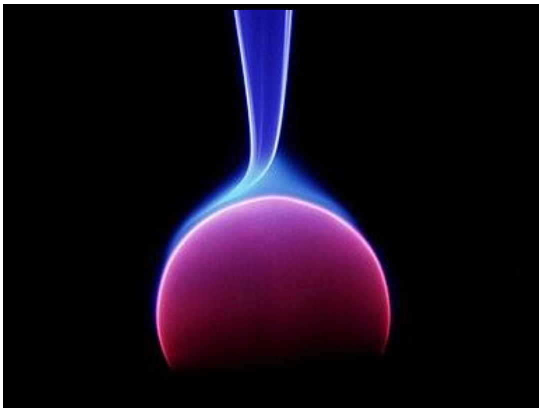
Atoms colliding in a gas.

21. **Elastic Force**:The elastic force is the force that arises from the deformation of a solid such as a spring or a rubber band.

Examples:

A stretched rubber band will move back to its original shape once the force that's stretching it is removed.

22. **Energy :** The capacity to do work or produce change. It exists in various forms such as kinetic, potential, thermal, etc.



Example:

A moving car has kinetic energy.

A stretched rubber band has potential energy.

23. **Equilibrium** :occurs when all forces acting on an object are balanced, and the object is at rest or in uniform motion.

Examples:

A book resting on a table.

A hanging lamp that remains stationary.

24. **Force:** A force is a push or pull acting on an object due to interaction with another object.

It is measured in newtons (N).

And it is also an influence that can cause an object to change its velocity unless counterbalanced by other forces.

Example :

Gravity pulling an apple toward the ground.

A person pushing a box across the floor .

25. **Free Fall** : Motion of an object under the influence of gravity alone, with negligible air resistance.

    Example:

    A small stone dropped from a height falls freely toward the ground.

26. **Friction**: is a force that opposes motion between two surfaces in contact.

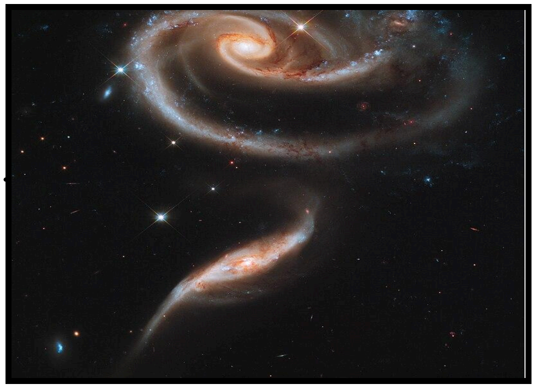
    And it only exists as a reactionary force that also has magnitude and direction .

Examples :

A bicycle stopped due to brake friction.

A person sliding down a hill slower than expected due to friction.

27. **Gravity :** is a force that pulls objects



toward each other. On Earth, it gives weight to objects.

And it is an invisible force that pulls objects toward each other .

Examples:

An apple falling from a tree.A person jumping and coming

back down.

28. **Impulse**: is the change in momentum of an object, caused by a force applied over a short time.

Examples:

Hitting a baseball with a bat.Kicking a soccer ball..

29. **Inertia :** is the tendency of an object to resist changes in its state of motion or rest. And it is the natural tendency of objects in motion to stay in motion and objects at rest to stay at rest , unless a force causes the velocity to change.

Examples:

A book remains at rest until pushed.A moving car continues to move unless brakes are applied.

30. **instantaneous speed**:Speed at some instant, or assumed constant during a very short period of time, is called instantaneous speed.

In mathematical terms, the instantaneous speed v is defined as the magnitude of the instantaneous velocity v that is, the derivative of the position r with respect to time

31. **Instantaneous velocity** : The instantaneous velocity of an object is the limit average velocity as the time interval approaches zero. At any particular time t, it can be calculated as the derivative of the position with respect to time
32. **Kinematics** : is the branch of physics

that deals with the motion of objects

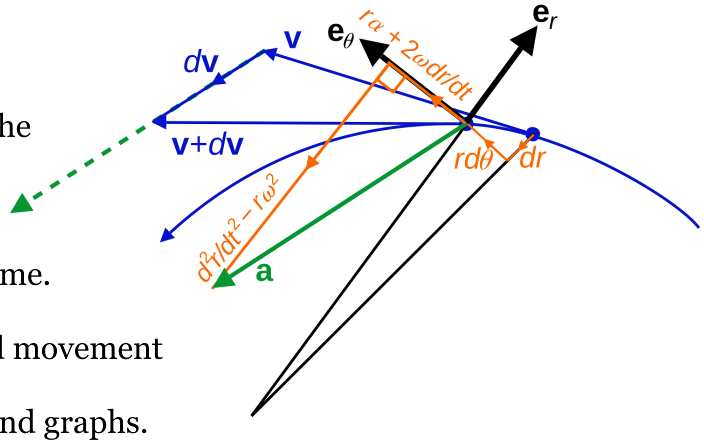
without considering the forces that cause the

motion. It involves studying concepts like

displacement, velocity, acceleration, and time.

Kinematics helps describe the position and movement

of objects using mathematical equations and graphs.



33. **Kinetic Energy** :The energy an object has due to its motion.

Example:

A cyclist riding down a hill.A bullet shot from a gun.

34. **Kinetic Friction**: is the frictional force acting between moving surfaces.

Examples:

A sled sliding down a snowy hill.A person skating on ice.

35. **Mass:** is the amount of matter in an object. It is measured in kilograms (kg) and does not change with location.

Example :

A 5 kg watermelon.A 1.5 kg laptop.

36. **Mechanical Energy**: The sum of kinetic and potential energy in a system

Example:

A swinging pendulum.

A roller coaster moving along its track.

37. **Momentum** : is the product of an object's mass and velocity. It determines how It is difficult to stop a moving object. And it is also a fundamental concept in physics that quantifies the motion possessed by an object.

Examples:

A moving truck has more momentum than a moving bicycle.

A soccer ball kicked hard has more momentum than one kicked softly.

38. **Motion:** Refers to the change in the position of an object over time relative to a reference point. It can occur in different forms, such as linear motion (along a straight line) or rotational motion (around an axis). The study of motion in

physics is known as kinematics, involving concepts like displacement, velocity, acceleration, and time.

Example:

Imagine a person riding a bicycle. As they pedal, they move from one point on a straight road to another.

Their position changes continuously with time, which means the person is in motion.

39. **Net Force**:is the overall force acting on an object when all the individual forces are combined.
40. **Newton's first Law** : An object at rest remains at rest , or if in motion , remains in motion at a constant velocity unless acted on by a net external force.

Examples:

One's body moves to the side when a car makes a sharp turn.

41. **Newton's Second Law** :This law states that the force acting on an object is equal to its mass multiplied by its acceleration (F = ma).

Examples:

A 2 kg object accelerating at 3 m/s^2 has a force of 6 N.

A football is kicked harder to increase its acceleration.

42. **Newton's Third Law** :If two bodies exert forces on each other, these forces have the same magnitude but opposite directions.
43. **Non-Uniform Motion** : Motion in which either speed or direction (or both) changes over time.

Example:

A cyclist going uphill and downhill in a zigzag path is in non-uniform motion.

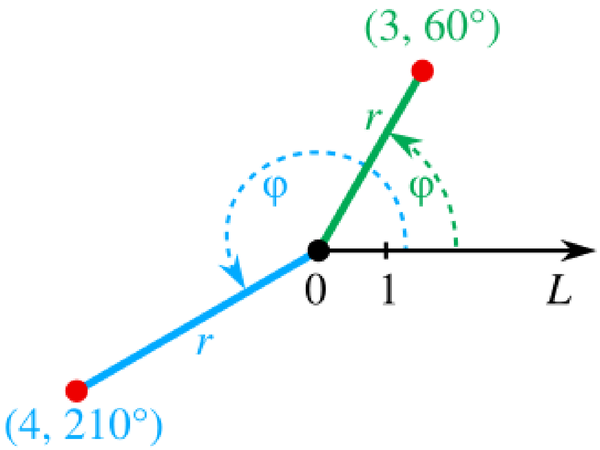
44. **Object** : A physical entity that occupies space with measurable size and shape, and whose motion is being studied.
45. **Particle**: A particle is an object with negligible size and shape considered as a single point mass to simplify the analysis of motion.

Example:

A small stone dropped from a tall building.

In kinematics, the stone can be treated as a particle because its size and shape are insignificant compared to the distance it travels.

46. **Polar Coordinate System:** A system that represents a point using a radial distance (r) and an angle (θ) measured from a fixed reference direction.



Example:

A point at (5, 30°) in a polar system is 5 units away from the origin at an angle of 30° from the x-axis.

47. **Potential Energy**: The stored energy in an object due to its position or configuration.

Example:

Water stored in a dam. A book placed on a shelf.

48. **Power:** is the rate at which work is done or energy is transferred. It is measured in watts (W).

Examples:

A motor lifting a load quickly.

A sprinter running a 100 m race.

49. **Projectile Motion**: A type of motion where an object moves in a curved path under the influence of gravity and an initial velocity.

Example:

A ball is thrown from the ground with an initial velocity at an angle to the horizontal.

50. **Radial distance:** typically denoted r or ρ, is the distance from the origin to a point along the radial dimension.
51. **Rotational Dynamics** :studies the
52. motion of objects rotating around an axis due to applied forces.

Examples:

A spinning top.

A rotating Ferris wheel.

53. **Scalar quantities** :or simply scalars are physical quantities that can be described by a single pure number (a scalar, typically a real number), accompanied by a unit of measurement, as in "10 cm".

Example:

length, mass, charge, volume, and time.

54. **Speed** : The rate at which an object covers distance in a given time. It is a scalar quantity (only magnitude, no direction).

Example:

A car traveling at 50 km/h covers 50 kilometers in one hour.

55. **Static Friction**: is the frictional force that prevents surfaces from sliding past each other.

Examples:

A book resting on a tilted table without sliding.A car parked on a hill.

56. **Tension**: is the pulling or stretching force transmitted axially along an object such as a string, rope, chain, rod, truss member, or other object, so as to stretch or pull apart the object.In terms of force, it is the opposite of compression.

Tension might also be described as the action-reaction pair of forces acting at each end of an object.

57. **Torque** : is a force that causes an object to rotate around an axis. It depends on the force and the distance from the axis. And it is a vector quantity.

Examples:

Using a wrench to turn a bolt. A seesaw tilting when pushed on one side.

58. **Trajectory** : The path that an object follows as it moves through space. It can be straight, curved, or depend on the type of motion.

Example:

A bullet fired from a gun in a vacuum (without gravity or air resistance) travels in a straight line.

59. **Uniform Motion:** Motion with constant speed, where acceleration is zero and there is no change in direction.

Example:

A car cruising on a straight highway at 60 km/h is in uniform motion.

60. **vector quantity** :(also known as a vector physical quantity, physical vector, or simply vector) is a vector-valued physical quantity.[1][2] It is typically formulated as the product of a unit of measurement and a vector numerical value (unitless), often a Euclidean vector with magnitude and direction. For example, a position vector in physical space may be expressed as three Cartesian coordinates with SI units of meters.
61. **Velocity** : The rate of change of displacement with time. It's a vector quantity, meaning it includes both magnitude and direction.

Example:

A car traveling at 60 km/h to the north has a velocity of

60 km/h north.

62. **weight** : weight of an object is a quantity associated with the gravitational force exerted on the object by other objects in its environment, although there is some variation and debate as to the exact definition.
63. **Work** :The transfer of energy when a force is applied to an object, causing it to move in the direction of the force.

Formula:

$$\text{Work} = \text{Force} \times \text{Distance} \times \cos(\theta)$$

Example:

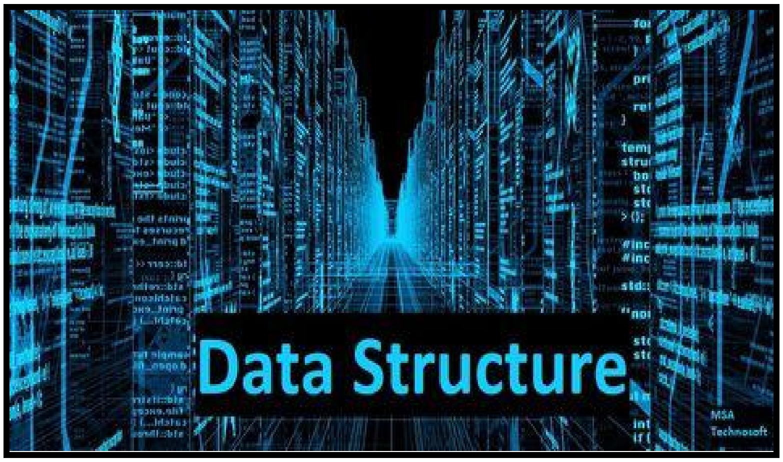
Lifting a box upwards does work on the box. Pushing a car across a parking lot is an example of work.

64. **Work-Energy Theorem** :The net work done on an object is equal to its change in kinetic energy.

Example:

Pushing a sled increases its speed and kinetic energy. Slowing down a car reduces its kinetic energy.

Algorithm and data structures



Algorithms and data structures are two fundamental concepts in computer science that work hand-in-hand to solve computational problems efficiently.

Data structures and algorithms are fundamentally interconnected, with data structures serving as the organizational framework for storing and managing data, while algorithms provide the step-by-step procedures to manipulate and process that data. The efficiency of an algorithm often depends on the choice of data structure, as different structures optimize different types of operations, such as searching, inserting, or deleting. For example, a hash table enables fast lookups, while a balanced tree ensures efficient sorting and retrieval. Together, they form the backbone of problem-solving in computer science, where selecting the right combination of data structure and algorithm is key to optimizing performance and resource usage

So , in short algorithms are like **recipes** that manipulate data, and data structures are like **ingredients** that hold the data.

1. **Algorithm:** is algorithm is an ordered sequence of instructions that indicates the procedure

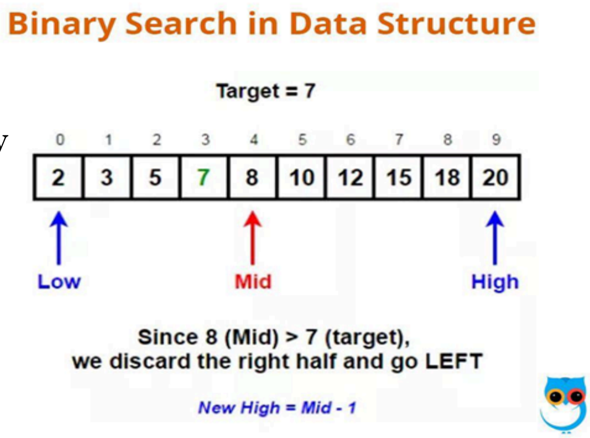
to be followed to solve a series of equivalent problems.

Example:

recipe for baking cake in an algorithm:

mix ingredients_ bake_Cool _decorate

1. **Arithmetic operations:**A data “type” is a set of values on which it is possible to apply a set of operations.• The “integer” type represents the set of relative integers. The operations that we may apply on the integers are: +, -, *, /, **, % (addition, subtraction,product division, power, modulo).We can also compare two integers using the comparison operators: £, <, =, >,
2. **ARRAY** :An array is a data structure T



which makes it possible to store a certain number

elements T[i] identified by an index i. Arrays generally

verify the following properties:

• All elements must have the same type.

• The number of stored elements is fixed beforehand.

3. **Array union** :Union of two arrays is an array having all distinct elements that are present in either array whereas Intersection of two arrays is an array containing distinct common elements between the two arrays. In this post, we will discuss Union and Intersection of sorted arrays.
4. **Binary search**:is a divide and conquer algorithm used to search for a target value with in a sorted array or list it works by repeatedly dividing the search interval in half
5. **Code**: refers to a set of instructions or commands written in a programming language that a computer can understand and execute.

6. **Computer program**:A computer program is a set of instructions given to a computer to process.

These instructions are usually used to solve a problem

7. **Condition**: a Boolean expression that determines whether the loop will continue executing
8. **Constants :**are fixed values that do not change throughout the execution of the algorithm,they are used to store data that remains the same, such as mathematical constants (eg pi=3,14)ExampleCircumference=2*pi*radius
9. **Data structure**: is a specialized format for organizing

managing,and storing data to enable efficient access \and

modifications.also data structure include arrays,stacks,

linked lists,trees.choosing the appropriate data structure

can significantly affect the performance of algorithms.

Example:

a binary tree is used in database indexing to enable faster data retrieval compared to a simple list

10. **Error** :*It is committing lapses or errors during the design stage of the program or while writing it in a programming language.

This error often results in poor or unexpected performance, and the word bug is often used when talking about any programming error.

11. **Graph:**a graph is a data structure consisting of nodes (vertices) and edges that connect pairs of nodes,graphs can be directed(edges have directions) or undirected (edges have no directions) they can also be weighted or unweighted

Example:

a graph can represent a network such as cities (nodes) connected by roads (edges)

12. **Hardware** :is therefore all the physical elements microprocessor,Memory,keyboard,harddisks....etc,used to process data
13. **Index:** an index is a position or location of an

element within an array list,or string.

Example:

accessing an element from a list using its index

Colors=(red,green,blue)

Print(colors(1)

output: green);

14. **Input**:in an algorithm refers to the data or values that are provided to the algorithm from an external source,such as a user,a file,or a sensor,for processing inputs are essential for making algorithms dynamic and adaptable to different scenarios.

Example

:An algorithm to calculate the square of a number takes an input number:

Num=int(input(enter a number))

Square=num*2

PRINT(the square of(num) is (square))

15. **Linux**:Linux is an open source operating system designed to run on multiple types of devices, such as laptops, phones, tablets, robots, and many more.
16. **Local variables in a function or procedure** :A local variable is a variable that can only be used inside the function/procedure.

It is thus declared inside the declaration of the function/procedure. By default,local variables are temporary. When Exiting the procedure/function, local variables are therefore lost.

Examples:

Procedure that “writes” the minimum of two integers procedure minimumProc (E/ x: integer, E/ y: integer);

Start if (x < y)

then output(x);else output(y);endif end procedure

17. **Alteration**:is the process of repeating a block of instructions in a program until a specified condition is met,it is implemented using control flow constructs such as loops (for,while,repeat)

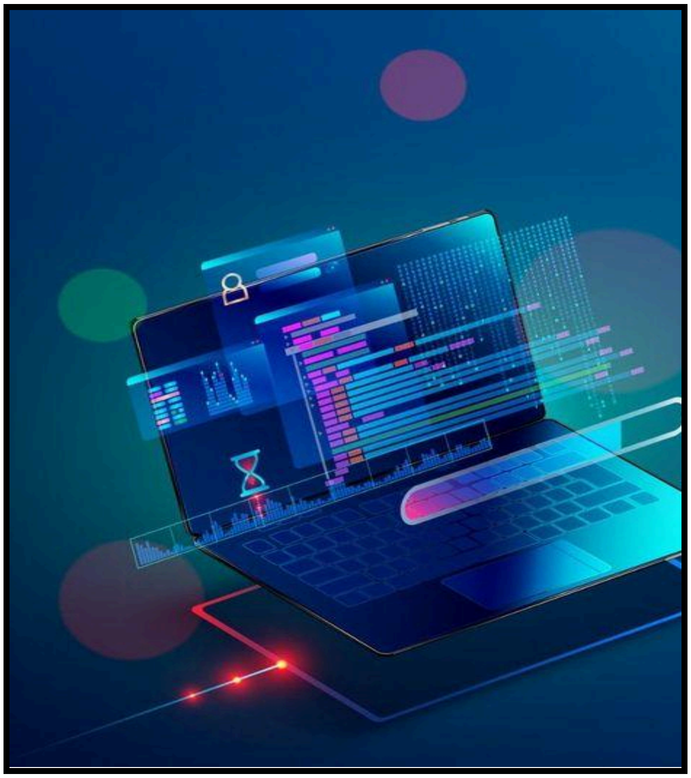
Example:

Printing the first 10 numbers using a for loop:For i=1 to 11 step 1 do

Print(i);

18. **Output**:refers to the result or information

produced by the algorithm after processing the input data, outputs can be displayed to the user, saved to a file,or passed to another program or function .



Example:

An algorithm that calculate and outputs the sum of two numbers

Num1=6

Num2=4

S=num1+num2

Output the sum of 6 and 4 is 10.

19. **procedure and function:**Both functions and procedures are small sections of code that can be repeated through a program.

The difference between them is that functions return a value to the program where procedures perform a specific task.

20. **Program:**A program is a set of instructions written in programming language that a computer can execute to perform specific task or solve a problem .programs are designed to process input manipulate date and produce the desired output
21. **Programming language:**A programming language is a set of instructions written by a programmer to deliver instructions to the computer to perform and accomplish a task. This set of instructions is usually viewed as incomprehensible code structure following a definite programming language syntax.

22. **Repeat loop :**is a type of loop structure that executes a block of code at least once and continues repeating the block until a specified condition is met,unlike other loops (like for or while),the condition is a repeat loop in checked after executing the loop body , insuring that the code runs at least one time, regardless of whether the condition is initially true

Example:

Repeat Perform some actionUntil condition is met.

23. **Return:**the return statement is used to send the result of a function back to the calling code.

Example:

returning the sum of two numbers

Read(a,b)

Return a+B

Result=add(3,7);

Print(10);

24. **Software**: is a structured soft of instructions describing information processing to be carried out by a computer (hardware)
25. **Stack** : a stack is a linear data structure that follows the last ln,first out (LIFO) principle, where the last element added is the first to be removed .
26. **Syntax in algorithmic language**:The declaration of an array is done as follows:a: array [dim] Tð Array variable a, whose elements are of type T and whose dimension is diE recall that the dimension is the size of the array, i.e. the maximum number of elements the array a can store.Example:a_int: array[8] integer;• Declares an array a_int whose elements are of type integer and whose size is 8.
27. **The for loop**:is a control flow statement that repeats a block of code a fixed number of times.it is commonly used when the number of iterations is known before the loop starts.Example:printing the number from1 to 5 :For i=1 to n step 1 do Instructions Print(i);
28. **Variables**:are symbolic names assigned to store data values in memory during the execution of an algorithm.

they are mutable,meaning their values can change throughout the algorithms Variables make algorithms flexible and reusable

Example:

VariablesN:integer

True/false:Boolean

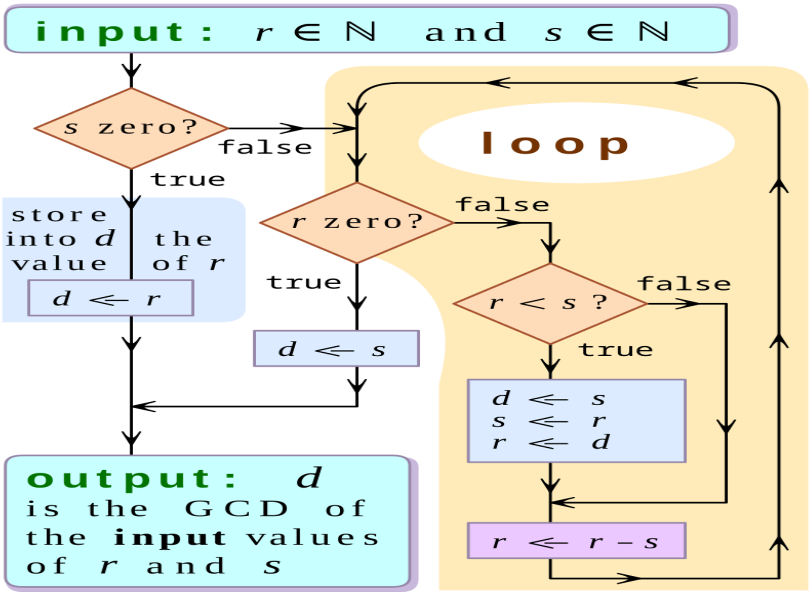
29. **While loop**:is a control structure that executes a block of code as long as the specified condition evaluates to true,it is often used when the number of iterations is not known in advance but depends on some conditions being met during the execution.

Example:

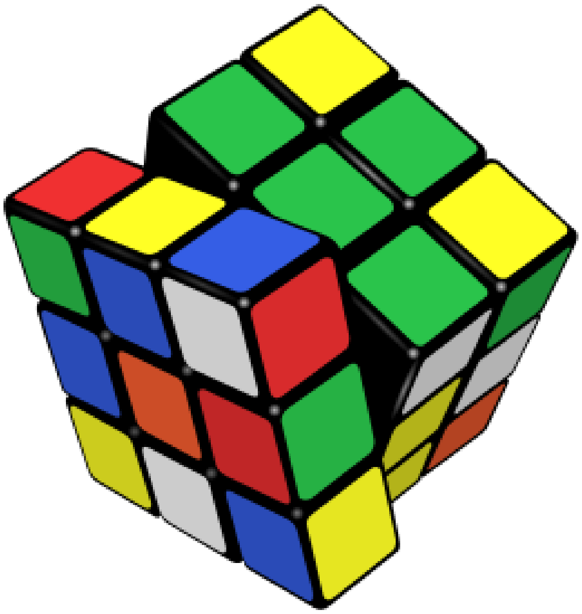
For i=1 to 20 step 1;

Read(i);S=0;

While(i<=10);S=s+1;



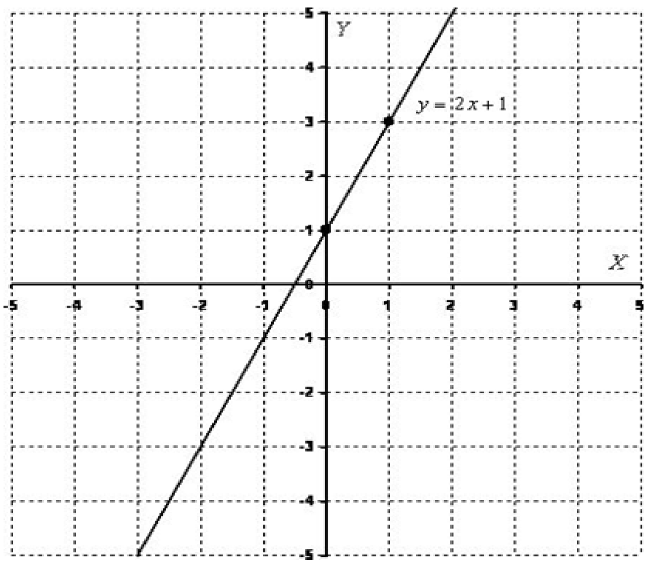
Algebra



Algebra is the branch of mathematics that studies certain abstract systems, known as algebraic structures, and the manipulation of statements within those systems. It is a generalization of arithmetic that introduces variables and algebraic operations other than the standard arithmetic operations such as addition and multiplication.

and This document provides an overview of the fundamental terms and concepts in algebra, which are essential for understanding and solving algebraic expressions and equations. By familiarizing yourself with these terms, you will build a strong foundation for further study in mathematics.

1. **Axioms or postulate (/ˈæk.si.əm/) :** is a fundamental statement that is assumed to be true without proof.



Example:

The Euclidean geometric one which

Say that it is possible to draw a straight line connecting two points.

2. **Bijection (bi.ʒɛk.sjɔ̃\):** Bijective is a special type of function that has two keys properties:

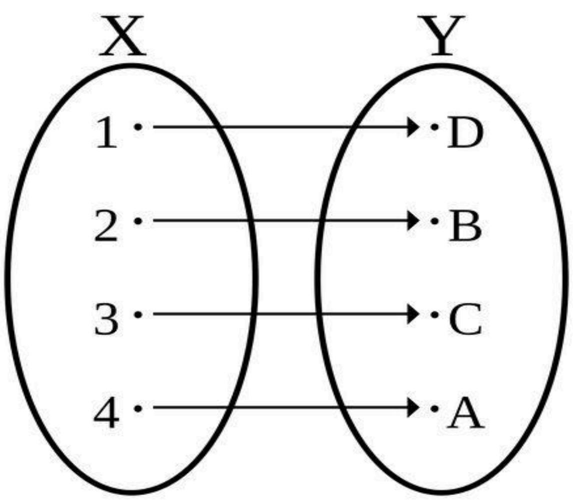
Injective (One-to-One): Each element of the domain (input) maps to a unique element in the co domain (output). No two different inputs produce the same output

. $f(x_1) = f(x_2) \implies x_1 = x_2$ f(x 1)=f(x 2)⟹x 1 =x 2

Surjective (Onto): Every element of the codomain has at least one element in the domain mapping to it. The function "covers" the entire codomain.

For every in the codomain, there exists an x in the domain such that $f(x) = y$.

For every y in the codomain, there exists an x in the domain such that f(x)=y. If a function is both injective and surjective, it is called bijective or a one-to-one correspondence. This means there is a perfect "pairing" between elements of the domain and codomain, making the function reversible.



Example:

Consider the function

f(x)=2x+1 defined from R to R:

It is injective because ....

f(x1) = f (x2) , implies 2* x1 + 1= 2*x2 +1, which simplifies to x1 = x2.

It is surjective because for every real number y there exists an x = y – 1\ 2, such that f(x) =y. Thus, f(x) is bijective.

3. **Cardinality (/ˈkɑːr.dɪnˈæl.ə.t̬i/):** The number of element of a set A for example is called the cardinality of A. and we denote it by card (A) or |A| or # A

Example:

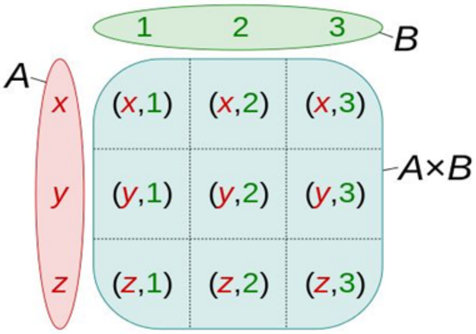
A= {1, 2, 3} the cardinality of A, denoted by ∣A∣, is 3 because there are three elements.

B= {a, b, c, d, e}, ∣B∣=5.

4. **Cartesian product (/kɑːrˈti.ʒən//ˈprɑː.dʌkt/):** Let A and B be two sets.

The Cartesian product of A and B is the set of all ordered pairs (a, b) with a∈ A and b∈ B. A×B= {(a, b) ∣ a∈A and b∈B}

Example:



Let A = { 1 , 2 } and B = { x , y }

The Cartesian product A × B is:

A × B = { (1 , x) , (1 , y) , (2 , x) , (2 , y) } .

5. **Co- domain (/koʊ-doʊˈmeɪn/):**

The codomain of a function is the set of all possible values that the function can output. It is the "target" set.

For a function f : A → B

B is the co-domain

Example:

..Let f (x) = x

And define the function as f: R → R

In this case the co-domain is R

6. **Complement of set (/ˈkɑːm.plə.ment, ɑːv, set/):**

Let A be a subset belongs to the S complement of A in S is the set of all elements of S which are not the elements of A.

We denote it by: S-A or Ac = {x |x ∈S and x∈ / A}

Example:

Let U = {1, 2, 3, 4, 5} (universal set).

Let A = {1, 2, 3}

The complement of A is: A c = {4, 5}

7. **Comparable elements (/kəmˈper.ə.bəl, /ˈel.ə.mənts/):**

Refer to elements that can be meaningfully compared within a given context, often using a relation such as ≤, <, or other ordering relations.

Example:

In the set S={2,4,6} with the relation "divides," 2 and 4 are comparable because 2 ∣ 4 but 4 and 6 are not comparable in this sense.

8. **Conjecture (/kənˈdʒek.tʃɚ/):** Is unproved statement that is believed to be true …

Example:

Gold Bach's conjecture states that any even integer greater than 3 can be written as the sum of two prime numbers

4=2+2

6=3+3

8=3+5

9. **Conjunction (/kənˈdʒʌŋk.ʃən/):** A conjunction is a compound statement formed by combining two statements using the logical operator AND (denoted by $\wedge$).

A conjunction $p \wedge q$ is true only if both p and q are true.

Example:

Let p represent "It is raining," and q represent "It is cold."

The conjunction $p \wedge q$ means "It is raining and it is cold."

10. **Co-restriction (/koʊ-, rɪˈstrɪk.ʃən/):**

A co-restriction of a function refers to restricting its codomain to the range of the function without changing the rule of assignment.

Example:

Consider the function $f: R \to R$ defined by $f(x) = x^2$

. Domain: R (all real numbers).

Codomain: R.

Range: $[0, \infty)$ (non-negative real numbers).

A co-restriction would change the codomain to $[0, \infty)$, so f becomes: $f: R \to [0, \infty)$.

11. **Definition (/ˌdef.ɪˈnɪʃ.ən/):** Is a statement that explains the significance of a word or phrase.

Example:

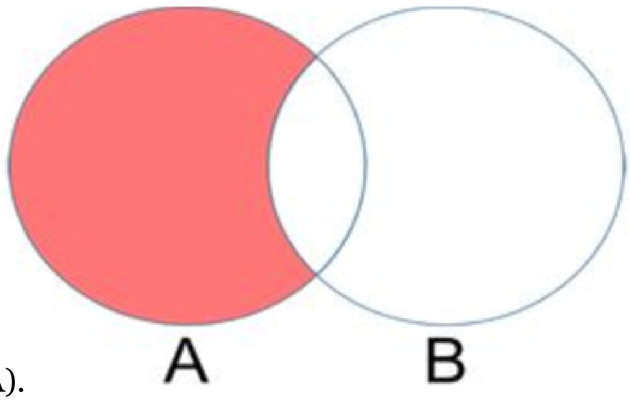
An integer n is said to be a prime number.

If it's greater than 1 and has no positive divisors other than 1 and itself.

12. Difference of sets (/ˈdɪf.ɚ.əns, ɑːv, sets/):

The difference of two sets A and B denoted by A-B OR A\B, is defined as the set of elements which belongs to A but not to B.

$A-B=\{x \in A \mid x \notin B\}$



Example:

Let A = { 1 , 2 , 3 , 4 and B = { 3 , 4 , 5 } .

A – B = {1, 2} (elements in A but not in B)

. B – A = {5} B–A= {5} (elements in B but not in A).

13. Disjunction (/dɪsˈdʒʌŋk.ʃən/):

Refers to a compound statement formed using the logical operator OR (denoted by $\vee$).

A disjunction is true if at least one of the statements involved is true.

For two statements p and q, the disjunction $p \vee q$ is true if either p is true, q is true, or both are true.

Example:

Let's define two statements:

"P "You will pass the exam.

"Q "You will get a scholarship.

The disjunction $p \vee q$ means: "You will pass the exam or you will get a scholarship.

14. Domain (/doʊˈmeɪn/):

Refers to the set of all possible input values (or "arguments") for which a function is defined. In simpler terms, it is the set of values you can plug into the function without causing undefined behavior**.**

For a function $f: A \rightarrow B$ the domain is the set A (the inputs).

Example:

Consider the function f(x) = x\ 1 .

The function is undefined at x = 0, because division by zero is not allowed.

The domain is R∖ {0}, meaning all real numbers except 0.

15. Empty set (/ˈemp.ti, set /):

A set containing no objects is said to be empty set and denoted by: **{ }**

Example:

The set of all integers between 1 and 2: $\{x \in Z \mid 1 < x < 2\} = \varnothing$

The solution set of the equation x ^2 +1=0 over R is ∅ because no real number satisfies the equation**.**

16. Equivalence (/ɪˈkwɪv.əl.əns/):

Refers to a relationship between objects, sets, or statements where they are considered equal or similar in a specific context.

17. Logical Equivalence (/ˈlɑː.dʒɪ.kəl, ɪˈkwɪv.əl.əns/):

Two statements are logically equivalent if they always have the same truth value. This is denoted as $p \Leftrightarrow q$ (if and only if).

Example:

The statements $p \rightarrow q$ and $\neg p \vee q$ are logically equivalent.

18. **Equivalence of Sets (ɪˈkwɪv.əl.əns , ɑːv, sets/):**Two sets A and B are equivalent (denoted A ~ B) if there is a bijection between them, meaning they have the same cardinality.

Example:

A = { 1 , 2 , 3 } and B = { a , b , c }

are equivalent because a one-to-one correspondence can be established.

19. **Existential (/ˌeg.zɪˈsten.ʃəl/):** Refers to a statement that asserts the existence of at least one element in a given domain that satisfies a certain property. Existential statements use the existential quantifier ∃ ∃, which means "there exists."

An existential statement is written as:

$$\exists \, X \in D \text{ such that } P(x)$$

This means "There exists at least one element x in the domain D such that the property P(x) holds."

20. **Finite set (/ˈfaɪ.naɪt, set /):** A set is said to be a finite set if it contains a finite number of elements, otherwise, we say that A is a finite set.

Example:

A = {1, 2, 3, 4} (contains 4 elements).

B = {a, b, c} (contains 3 elements).

The set of all days in a week: C = {Monday, Tuesday, ..., Sunday}

21. **Group (/ɡruːp/):** A group is a set equipped with an operation that satisfies four key properties: closure, associativity, the existence of an identity element, and the existence of inverses.

Example:

Integers under Addition: The set of integers Z with the operation of addition (+) forms a group:

Closure: Sum of two integers is an integer. Associativity: $(a + b) + c = a + (b + c)$

Identity: 0 is the identity element ($a+0=a$)

Inverse: For every a, the inverse is $a+ (-a) =0$).

Multiplication: The set $R*$ (non-zero real numbers) under multiplication ($\cdot$) : Identity: 1 (since $a \cdot 1 = a$).

Inverse: For every a, the inverse is $1/a$.

Symmetric Group Sn : The set of all permutations of n elements forms a group under composition.

22. **Group Homomorphism (/ɡruːp , ˈhoʊ.moʊ, mɔːr.fɪ.zəm/):** A group homomorphism is a function between two groups that preserves the group operation. In simpler terms, it maps elements from one group to another in a way that respects the structure of the groups.

Let $(G, *)$ and $(H,*)$ be in two groups.

A function $\phi:G\rightarrow H$ is a group homomorphism if, for all $a , b \in G$, $\phi (a * b) = \phi (a) \cdot \phi (b)$

Example:

Homomorphism from $(Z , +)$ to $(Z n , +)$,Define $\phi : Z \rightarrow Z n$ by $\phi (a) = a \bmod n$

. This is a homomorphism because: $\phi (a + b) = (a + b)$

$\bmod n = (a \bmod n + b \bmod n)$,$\bmod n = \phi (a) + \phi (b)$

23. **Image (/ˈɪm.ɪdʒ/):** Refers to the set of all output values that result from applying a function to every element in its domain.

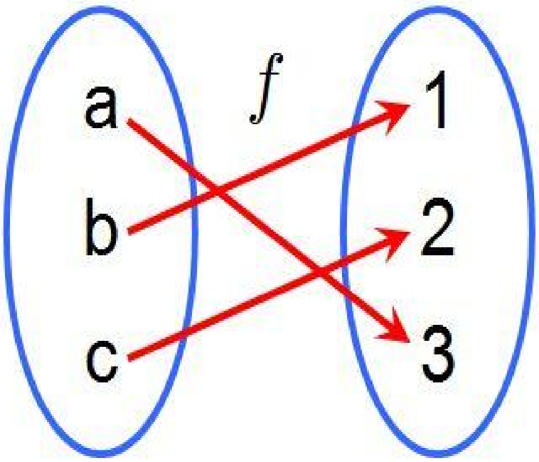
For a function $f : A \rightarrow B$, the image (or range) of f is the set of all elements in B that are mapped to by elements in A :

Image (f) = { f (x) ∣ x ∈ A } .

A: Domain (inputs).

B: Codomain (possible outputs).

Image of f: The actual outputs.



Example:

Let f(x) =x^2, where x∈ {−2, −1, 0, 1, 2}.

Domain: {− 2, − 1, 0, 1, 2}

Image: f (− 2) = 4 , f (− 1) = 1 , f (0) = 0 , f (1) = 1 , f (2) = 4 .

The image is: {0, 1, 4**}.**

24. **Implication (/ˌɪm.pləˈkeɪ.ʃən/) :**Refers to a statement that expresses a conditional relationship between two propositions. It is denoted by the symbol → and reads as "if p, then q ".

An implication p → q means that whenever p (the hypothesis or antecedent) is true, q (the conclusion or consequent) must also be true. It does not assert that p or q are actually true but rather describes a logical relationship between them.

Example:

P: "A number n is even."

q: "The number n^2 is even.

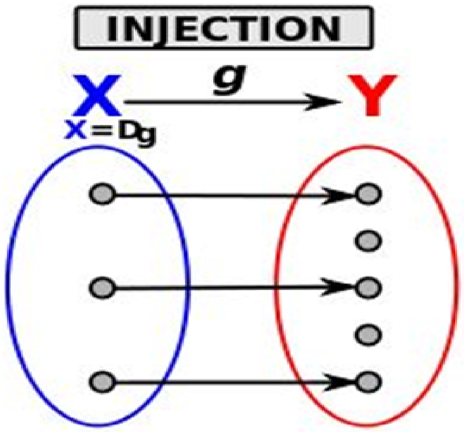
«The implication p → q is true because every even number squared is also even.

25. **Infinite set (/ˈɪn.fə.nət, set/):** An infinite set is a set that has an uncountable or unlimited number of elements. Unlike finite sets, infinite sets cannot be counted or exhausted by listing all their elements.

A set is called infinite if it is not finite, meaning it does not have a specific number of elements. Formally, a set A is infinite if there is no bijection between A and any finite set { 1 , 2 , ... , n } for some natural number n .

26. **Injection (/ɪnˈdʒek.ʃən/):** An injection or injective function is a function that maps distinct elements of its domain to distinct elements of its codomain. In other words, no two different inputs produce the same output.

A function f: A → B is called injective (or one-to-one)



if: $\forall$ x1, x2$\in$ A, f (x1) = f (x2) $\Rightarrow$ x1 = x2

This means that if two inputs produce the same output,

they must be the same input.

Example:

R→R defined f(x) =2x+3.

For any two different x1, x2, we have f (x1) ≠ f (x2)

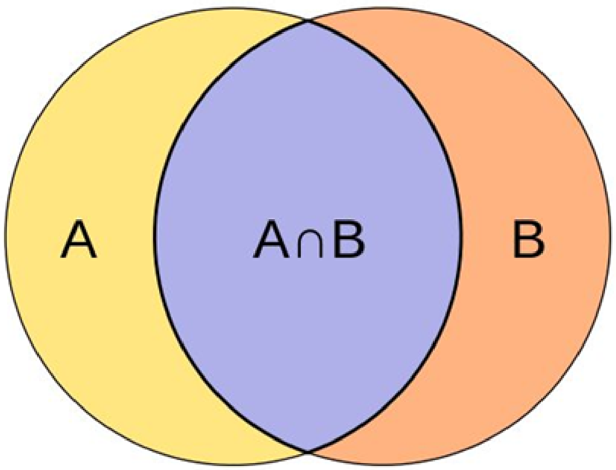
Example: f (1) =5 and f (2) =7.

27. **Intersection (/ˌɪn.t̬ɚˈsek.ʃən/):** The intersection of

two sets A and B is the set which consists of all those

elements which belong to both A and B we denote

it by A∩B Such that:



A∩B={x | x∈A and x∈B}

Example:

Let A = { 1 , 2 , 3 } and B = { 2 , 3 , 4 }

A∩B = {2, 3}.

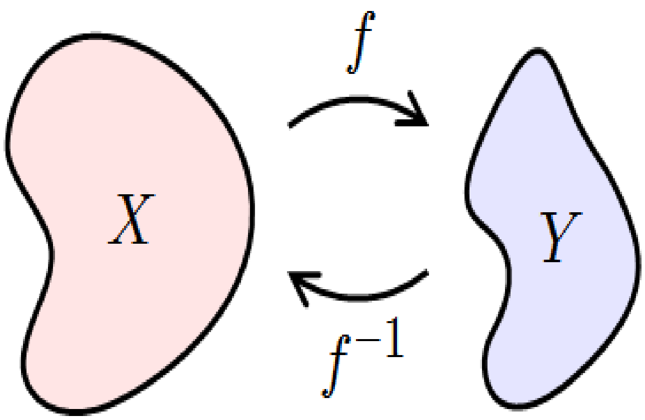
The intersection contains the elements that appear in both sets.

28. **Inverse map (/ɪnˈvɝːs, mæp/) :** An inverse map (or inverse function) is a function that "reverses" the effect of another function. If a function f maps elements from set A to set B , the inverse function f ^− 1 maps elements from B back to A .

Let f: A → B be a function.

The inverse function f ^− 1: B → exists if and only if f is a bijection (both injective and surjective).

Example:



Let g: R + → R + be the function g (x) = x^2.

To find the inverse, we solve for x in terms of y: y = x^2

x = SQRT (y) Thus, the inverse function is:

g^− 1 (y) = SQRT (y).

29. **Linear Equation (/ˌlɪn.i.ɚ ɪˈkweɪ.ʒən/)**:A linear equation is an algebraic equation involving only a constant and a first-order (linear) term, where it's a polynomial equation of the first degree.

Example:

$$f(x)=3x+2$$

30. **Map (/mæp/):** A map (also called a function) from set A to set B is a rule that associates each element in A to exactly one element in B. This is typically denoted as f: A → B.
31. **Multiset (/mʌl.ti-,, set) :**A multiset is a collection of elements where: Order does not matter (just like in a set). Repetition of elements is allowed (unlike in a set).

Example:

Multiset M = {1, 1, 2, 3, 3, 3}.

1 has multiplicity 2.

2 has multiplicity 1.

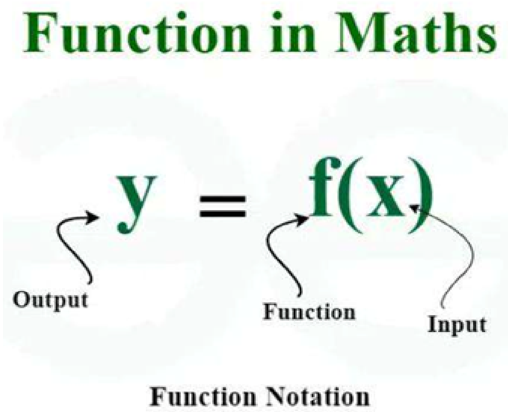
3 has multiplicity 3.

32. **Predicates (/ˈpred.ə.kət/):** A predicate is a mathematical sentence that contains number of variables and becomes a statement when specific values are substituted for the variables.

Example:

The sentence defined over the set of the real numbers, n is a prime number is a predicate defined over N.

33. **Preimage (/priː-ˈɪm.ɪdʒ/):** Refers to the set of all elements from the domain that map to a given set in the codomain. If you have a function f: A → B, the preimage of a subset C ⊆ B is the set of all elements in A that f maps to elements of C.



Let f: A → B be a function.

For any subset C ⊆ B, the preimage of

C, denoted f^−1 (C) is defined as:

f^−1(C) = { x ∈ A ∣ f (x) ∈ C }

In other words, the preimage of

C is the set of all elements in A that are mapped by f into C .

Example:

Let f: R → R be the function f (x) = x^2.

Let C = [0, 4] ⊆ R.

We want to find the preimage of C, $f^{-1}([0,4])$.

The set [0, 4] consists of all real numbers y

such that $0 \le y \le 4$].

To find the preimage, we solve for x such that $f(x) = x^2 \in [0, 4]$ $0 \le x^2 \le 4$.

Solving this gives: $-2 \le x \le 2$ Therefore, the preimage is: $f^{-1}([0, 4]) = [-2, 2]$.

34. **Power set (/ˈpaʊ.ɚ/):** The power set of a set S, denoted as P(S) or 2^S, is the set of all possible subsets of S, including the empty set and S itself. In other words, the power set contains every combination of elements from S, from the empty set to the set S itself.

$$P(S) = \{A \mid A \subseteq S\}$$

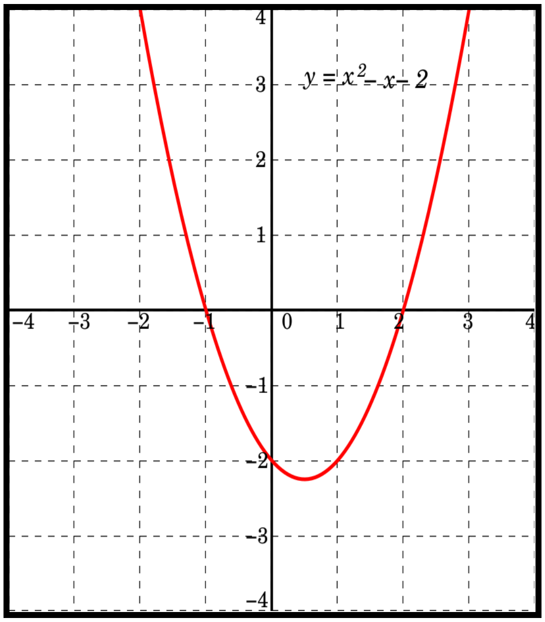
Example:

Let S = {a, b}.

The power set of S is: P(S) = {∅, {a}, {b}, {a, b}}

This set contains 4 subsets: the empty set, two single-element subsets, and the full set.

35. **quadratic equation (/kwɑːdˌræt̬.ɪk ɪˈkweɪ.ʒən/):** an equation in which the highest power of an unknown quantity is a square.



A quadratic equation is a polynomial equation

of the form:

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

\Example:

$2x^2-4x-6=0$

Steps to Solve:

Identify coefficients:

a=2a b=−4b c=−6

Use the quadratic formula:

Substitute the values:

Solve for x: x=3 x=-1

36. **Restriction (/rɪˈstrɪk.ʃən/):** Refers to limiting the domain of the function to a subset of its original domain. When you restrict a function, you apply the function to only a specific portion of the original set, which results in a new function with a smaller domain.

Let f: A → B be a function. If C ⊆ A is a subset of the domain A, the restriction of f to C, denoted $f|_C$, is the function: $f|_C: C \to B$

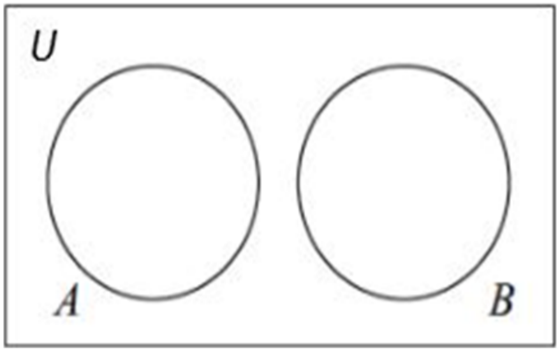
Example:

Let f: Z → Z be the function f(x)=2x, where Z is the set of integers.

Let C= {1, 2, 3}. The restriction of f to C is: $f|_C : \{1, 2, 3\} \to Z$, $f|_C(x) = 2x$ for $x \in \{1, 2, 3\}$

The restricted function is: $f|_C(1) = 2$, $f|_C(2) = 4$, $f|_C(3) = 6$

37. **Set (/set/):** A set is a well-defined collection of distinct objects, considered as an entity in its own right. The objects in a set are called elements or members of the set.



Example:

Let A= {1, 2, 3} and B= {3, 4, 5}

38. **Statement or proposition (/ˈsteɪt.mənt/):** is a declarative sentence that is either true or false.

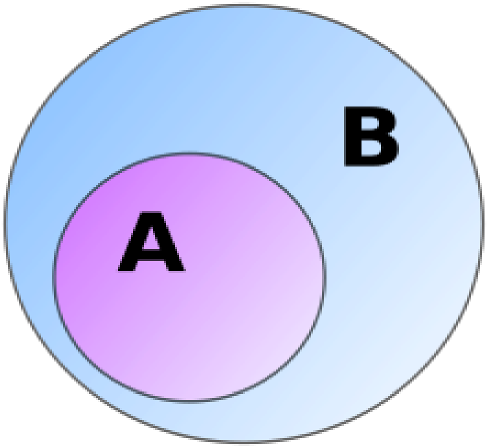
Example:

1- The expression: 1-3=-2 is true.

2-the expression -1<-2 Is false.

39. Subset (/ˈsʌb.set/):

A set A is said to be subset of a set B, if all elements of A are also elements from B



Denoted by: A ⊆ B

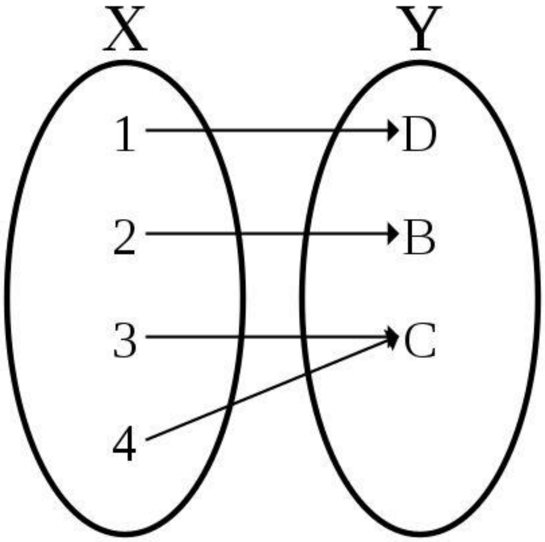
Example:

Let A= {1, 2} and B= {1, 2, 3, 4}.

Since every element of A (which are 1 and 2) is also an element of B, we say: A ⊆ B. In this case, A is a proper subset of B

40. **Surjection (/sərˈdʒek.ʃən/):**

A surjection (also called onto function) is a type of function where every element in the codomain has at least one element from the domain that maps to it. In simpler terms, for a function to be **surjective**, every element in the codomain must be the image of some element from the domain.



Let f: A → B be a function from set A (the domain)

to set B (the codomain).

The function f is called a surjection (or onto function) if for every element $b \in B$, there exists at least one element $a \in A$ such that. F (a) =b.

Example:

Let $f : \{ 1 , 2 , 3 \} \rightarrow \{ a , b , c \}$ be a function defined by: $f (1) = a$, $f (2) = b$, $f (3) = c$. Every element in the codomain {a, b, c} has a corresponding element

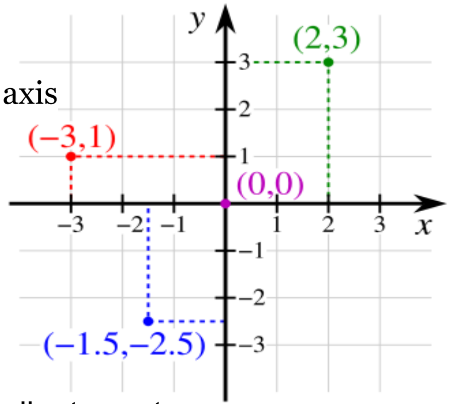
in the domain {1, 2, 3}, so this function is a surjection.

41. **Theorem (/ˈθiː.rəm/):** Is a statement that has been proved to be true.

Example:

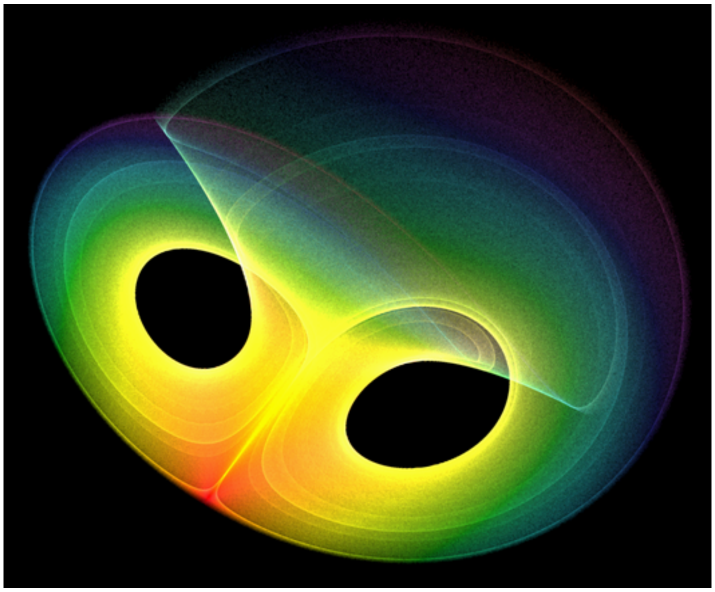
Theorem (Pythagorean Theorem): In a right-angled triangle, the square of the length of the hypotenuse (the side opposite the right angle) is equal to the sum of the squares of the lengths of the other two sides.

42. **X-Axis (/ˈeks ˌæk.sɪs/):** The x-axis is the horizontal axis of a two-dimensional plot in Cartesian coordinates that is conventionally oriented to point to the right (left figure).



43. **y-axis(/ˈwaɪ ˌæk.sɪs/):** the vertical axis in a plane coordinate system

Analyses



Analysis is the branch of mathematics dealing with continuous functions, limits, and related theories, such as differentiation, integration, measure, infinite sequences, series, and analytic functions.[1][2]

These theories are usually studied in the context of real and complex numbers and functions. Analysis evolved from calculus, which involves the elementary concepts and techniques of analysis. Analysis may be distinguished from geometry; however, it can be applied to any space of mathematical objects that has a definition of nearness (a topological space) or specific distances between objects (a metric space).

1. **absolute value** : or **modulus** of a real number X, denoted | X | , is the non-negative value of X without regard to its sign. It may be thought of as its distance from zero.

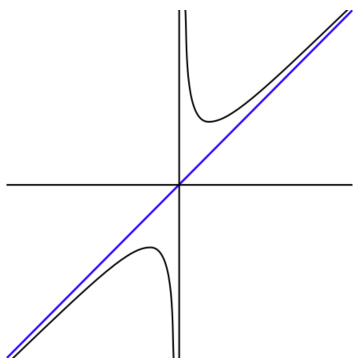
   Example : $|-2x| = 2x$

2. **Associative property** : a property of some binary operations that means that rearranging the parentheses in an expression will not change the result.

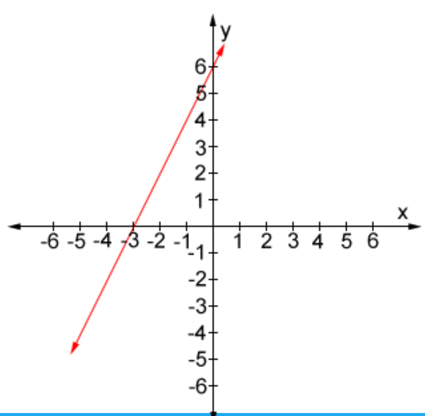
   Example : let a , b and c be real numbers :

$$(a+b)+c=a+(b+c)$$

3. **Asymptote :** an **asymptote** (/ˈæsɪmptoʊt/) of a curve is a line such that the distance between the curve and the line approaches zero as one or both of the *x* or *y* coordinates tends to infinity.



4. **Axis :** An axis is a line with respect to which a curve or figure is drawn, measured, rotated, etc. The most common axes encountered are commonly the mutually perpendicular Cartesian axes in the plane or in space.



5. **Axiom** : a proposition regarded as self-evidently true without a proof , it is a slightly archaic synonym for postulate .

Example : we take without proof that for any two real numbers a and b

$$a+b = b+a$$

6. **Bounded set :** A set is called bounded if it has a finite size. If a set is consisting both upper and lower bound values, then we will consider it as a totally bounded set.

7. **Characterization :** A description of an object by properties that are different from those mentioned in its definition, but are equivalent to them. The following list gives a number of examples.

   Example : A rational number, generally defined as a ratio of two integers, can be characterized as a number with finite or repeating decimal expansion.

$$\boxed{r = b_k b_{k-1} \cdots b_0 . a_1 a_2 \cdots}$$

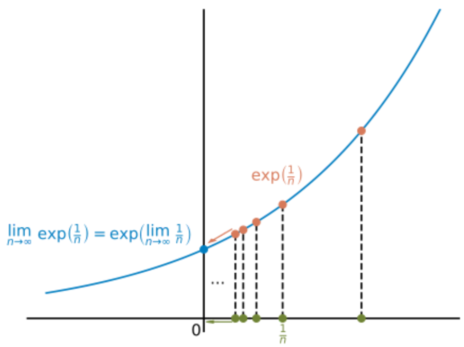
8. **Completeness :** a property of the real numbers that, intuitively, implies that there are no "gaps" (in Dedekind's terminology) or "missing points" in the real number line.
9. **Commutative property** : a binary operation is if changing the order of the operands does not change the result .

   Example : for any real number X and Y we have

$$X.Y = Y.X$$

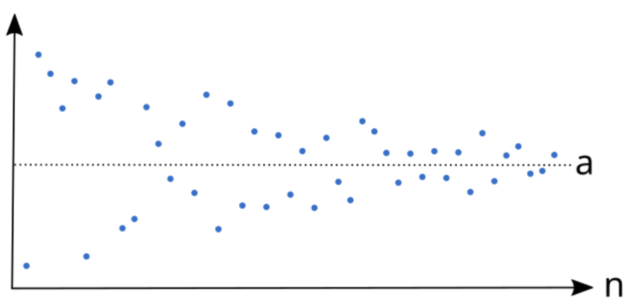
10. **Continuous Function :** a function whose graph is continuous without any breaks or jumps. i.e., if we are able to draw the curve (graph) of a function without even lifting the pencil.

Example :

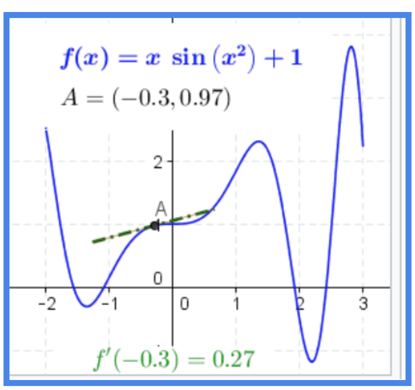


--This function is continuous over its domain,thus we don't see gaps in the graph -

11. **Convergent :** it essentially means that the respective series or sequence approaches some limit (D'Angelo and West 2000, p. 259) .



12. **Differentiation** :the process of finding the derivative, or rate of change, of a function. In contrast to the abstract nature of the theory behind it, the practical technique of differentiation can be carried out by purely algebraic manipulations .



13. **Domain :** a non-empty, connected, and open set in a topological space. In particular, it is any non-empty connected open subset of the real coordinate space $\mathbf{R}^n$ or the complex coordinate space $\mathbf{C}^n$.

14. **Equation** : a mathematical formula that expresses the equality of two expressions, by connecting them with the equals sign =.

Example :

3X +13 = 5X +2

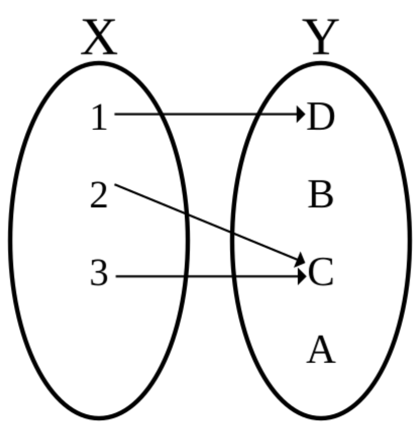
15. **Field** : a set on which addition, subtraction, multiplication, and division are defined and behave as the corresponding operations on rational and real numbers.

16. **Formula :** a fact, rule, or principle that is expressed in terms of mathematical symbols. Examples of formulas include equations, equalities, identities, inequalities, and asymptotic expressions.

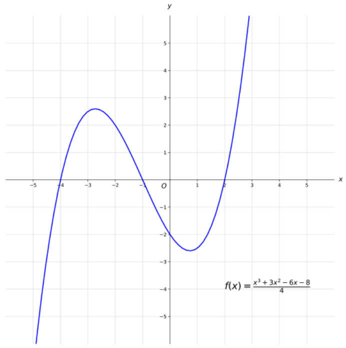
Example :

$$\boxed{\binom{m+n}{r} = \sum_{k=0}^{r} \binom{m}{k} \binom{n}{r-k}}$$

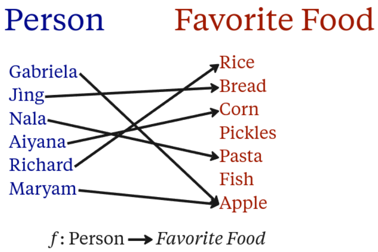
17. **Function :** A function is a relation that uniquely associates members of one set with members of another set.



18. **Graph :** the **graph of a function** F is the set of ordered pairs (X , Y) , where F(X)=Y In the common case where X and Y are real numbers, these pairs are Cartesian coordinates of points in a plane and often form a curve.

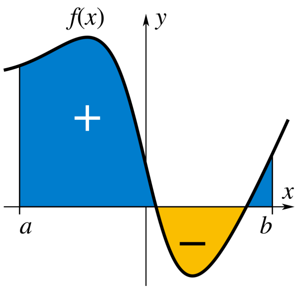


19. **Inequality :** a relation which makes a non-equal comparison between two numbers or other mathematical expressions. It is used most often to compare two numbers on the number line by their size. The main types of inequality are **less than** (<) and **greater than** (>).
20. **Image :** the **image** of an input value X is the single output value produced by F (the function) when passed X.



21. **Infimum** : is the greatest lower bound in the set.

22. **Integrals :** is the continuous analog of a sum, which is used to calculate areas, volumes, and their generalizations. Integration, the process of computing an integral .



23. **[Intger part function (floor function) :](#)** is the function that takes as input a real number x, and gives as output the greatest integer less than or equal to x.

Example :

$$\boxed{\lfloor 2.4 \rfloor = 2,\ \lfloor -2.4 \rfloor = -3}$$

24. **Interval** the set of all real numbers lying between two fixed endpoints with no "gaps".

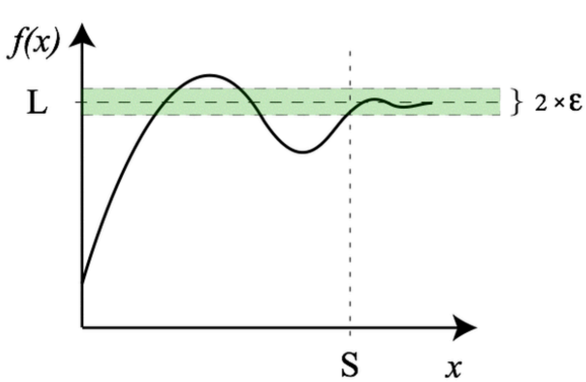
25. **Irrational numbers :** are all the real numbers that are not rational numbers. That is, irrational numbers cannot be expressed as the ratio of two integers.

Example :

Here is an approximate value of some irrational numbers :

Symbol	Name	Value
π	Pi	3.141592653589793
e	Euler	2.718281828459045
$\sqrt{2}$	Square root of 2	1.41421356237

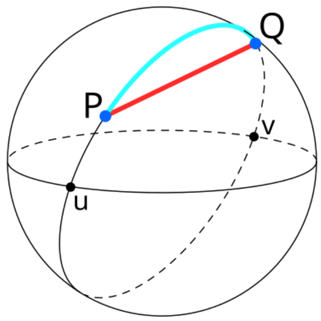
26. **Limit :** a limit is the value that a function (or sequence) approaches as the argument (or index) approaches some value.



27. **Maximum** : the greatest and value taken by the function.
28. **Metric space :** a set together with a notion of *distance* between its elements, usually called points. The distance is measured by a function called a **metric** or **distance function**.

    Example :

    The most familiar example of a metric space is 3-dimensional Euclidean space with its usual notion of distance. Other well-known examples are a sphere equipped with the angular distance and the hyperbolic plane.



29. **Minimum :** The least value taken by the function.

30. **Monotone:** a **monotonic function** (or **monotone function**) is a function between ordered sets that preserves or reverses the given order.

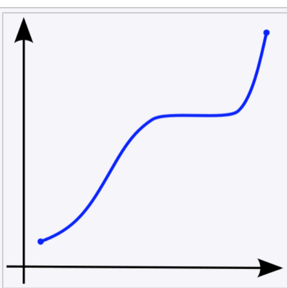


Figure 1. A monotonically non-decreasing function

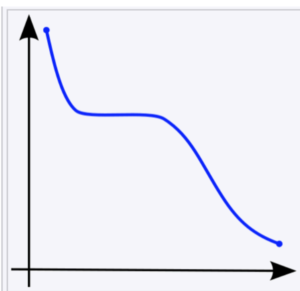


Figure 2. A monotonically non-increasing function

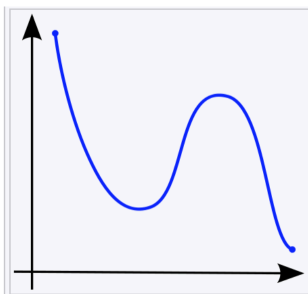
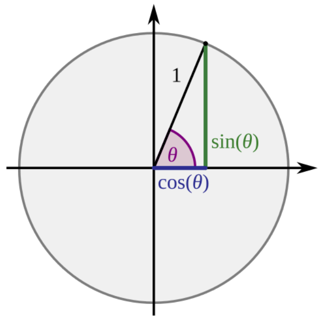
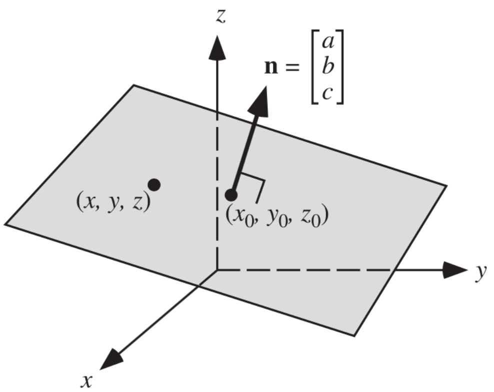


Figure 3. A function that is *not* monotonic

31. **Trigonometry:** is concerned with relationships between angles and side lengths of triangles. In particular, the trigonometric functions relate the angles of a right triangle with ratios of its side lengths.



32. **Plane :** A plane is a two-dimensional doubly ruled surface spanned by two linearly independent vectors. The generalization of the plane to higher dimensions is called a hyperplane.

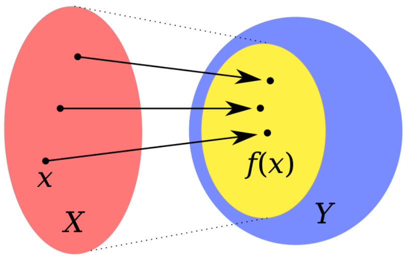


33. **Polar form :** The polar form of a complex number is another way of representing complex numbers. The form z = a+bi is the rectangular form of a complex number, where (a, b) are the rectangular coordinates. The polar form of a complex number is represented in terms of modulus and argument of the complex number.

$$= r(\cos(\varphi) + \mathrm{i}\sin(\varphi)) = r\mathrm{e}^{\mathrm{i}\varphi}$$

34. **Pre-image :** The preimage of an output value Y is the set of input values that produce Y.

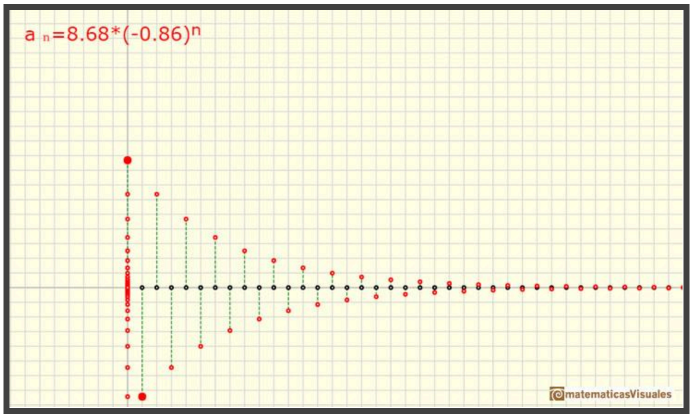
35. **Range:** The range of a function may refer to either of two closely related concepts:
    - the codomain of the function, or
    - the image of the function.



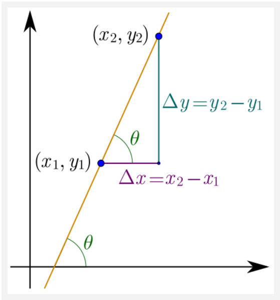
$f : X \to Y$

36. **Sequences :** they are ordered lists of numbers (called "terms"), like 2,5,8. Some sequences follow a specific pattern that can be used to extend them indefinitely.

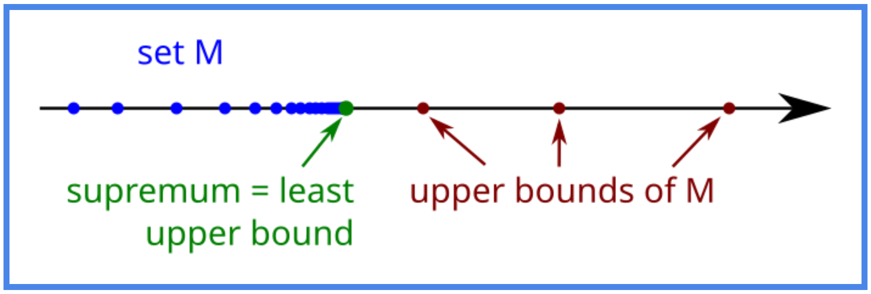
    Example: 2,5,8 follows the pattern "add 3".



37. **Slope:** the slope or gradient of a line is a number that describes the direction of the line on a plane.[1] Often denoted by the letter m, slope is calculated as the ratio of the vertical change to the horizontal change ("rise over run") between two distinct points on the line, giving the same number for any choice of points.

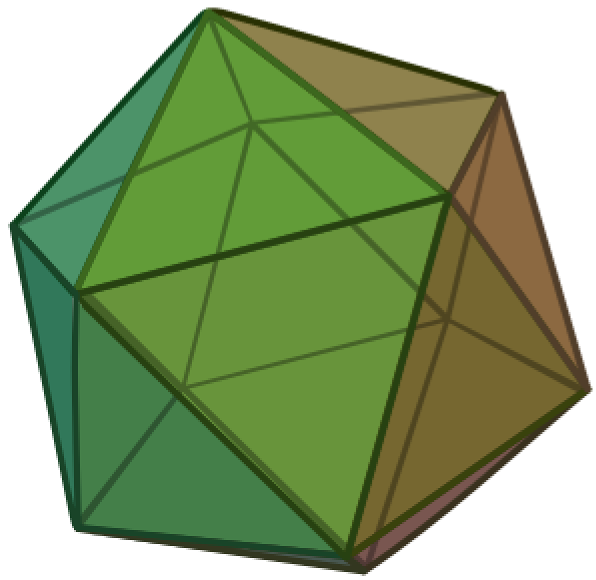


38. **Supremum :** is the least upper bound number in the set.



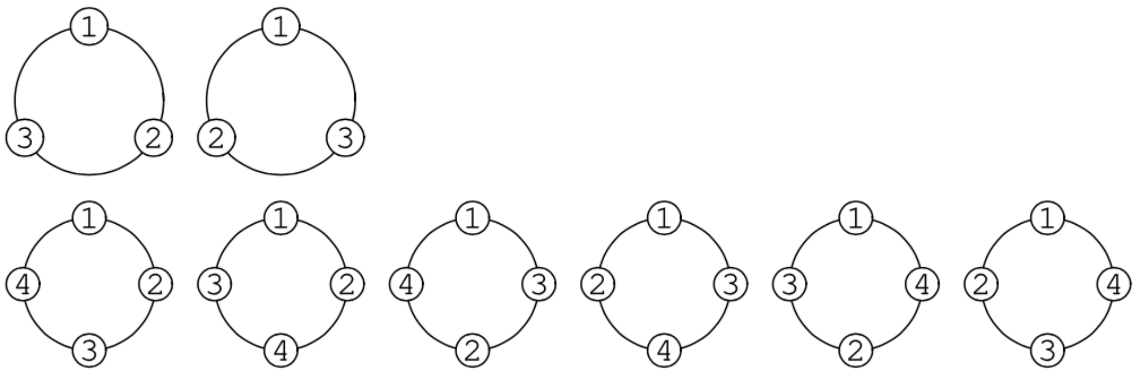
39. **Topology :** (/təˈpɑlədʒi/) it's the study of shapes that can be stretched and moved while points on the shape continue to stay close to each other .
40. **Variable :** A variable is a quantity that may be changed according to the mathematical problem. Like X or Y

Discret Mathematics



Discrete mathematics is the study of mathematical structures that can be considered "discrete" (in a way analogous to discrete variables, having a bijection with the set of natural numbers) rather than "continuous" (analogously to continuous functions). Objects studied in discrete mathematics include integers, graphs, and statements in logic .

1. **Arrangement :** In general, an arrangement of objects is simply a grouping of them. The number of "arrangements" of N items is given either by a combination (order is ignored) or permutation (order is significant).
2. **binomial theorem:** states the principle for expanding the algebraic expression n and expresses it as a sum of the terms involving individual exponents of variables x and y.
3. **Circular permutation :** The number of ways to arrange distinct objects along a fixed (i.e., cannot be picked up out of the plane and turned over) circle .



4. **Coefficient :** s a multiplicative factor involved in some term of a polynomial, a series, or any other type of expression. It may be a number without units, in which case it is known as a numerical factor.
5. **Counting:** is the process of determining the number of elements of a finite set of objects; that is, determining the size of a set.
6. **combinations** :is a mathematical technique that determines the number of possible arrangements in a collection of items where the order of the selection does not matter.

7. **Combinatorial proof :** A combinatorial identity is proven by counting the number of elements of some carefully chosen set in two different ways to obtain the different expressions in the identity. Since those expressions count the same objects, they must be equal to each other and thus the identity is established.

8. **derangement:** is a permutation of the elements of a set in which no element appears in its original position. In other words, a derangement is a permutation that has no fixed points.

   Example : might be a dance class in which five brother-sister pairs are enrolled,The instructor mixes them up so that no one is dancing with a sibling.

9. **Digit :** any of the Arabic numerals 1 to 9 and usually the symbol 0.

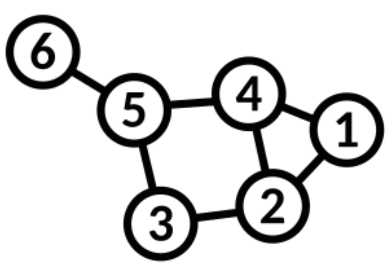
10. **disposition:** is the arrangement of k elements chosen from a set of n elements, where order matters.

    example : Choosing Students for a Lineup.

11. **Distinguishable :**if an object can be uniquely identified or differentiated from other objects within a set.

    example: three different books labeled A, B, and C. These books are distinguishable because each has a unique label.

12. **Graph theory :** is the study of *graphs*, which are mathematical structures used to model pairwise relations between objects.



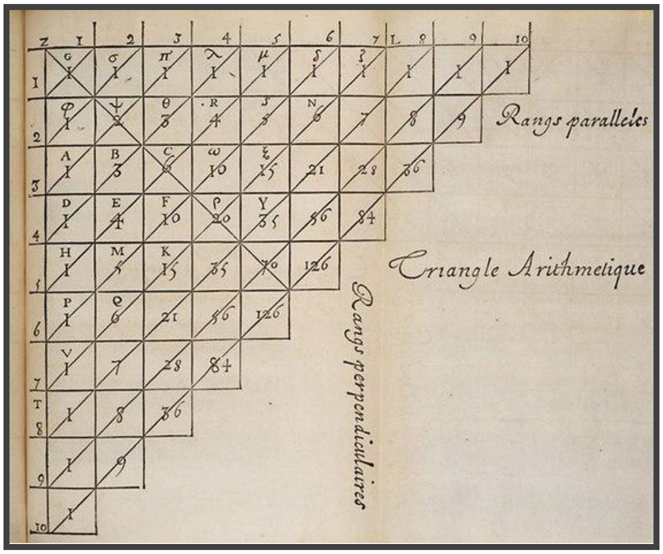
13. **Indistinguishable:** refers to objects that cannot be distinguished from one another based on their properties or labeling and swapping them does not result in a different outcome or arrangement.

example: arranging 3 indistinguishable balls into 3 distinguishable bins (labeled 1, 2, 3).

14. **LHS:** is informal shorthand for the left-hand side of an equation.

15. **Ménage problem:** the ménage problem or problème des ménages asks for the number of different ways in which it is possible to seat a set of male-female couples at a round dining table so that men and women alternate and nobody sits next to his or her partner.
16. **multinomial theorem:** describes how to expand a power of a sum in terms of powers of the terms in that sum. It is the generalization of the binomial theorem from binomials to multinomials.
17. **Order:** refers to the arrangement of elements in a set ,It determines whether the position of elements matters in a particular context.Example: For elements {A, B, C}, the order ABC is different from BAC.

18. **Pascal's triangle:** is a triangular arrangement of numbers that gives the coefficients in the expansion of any binomial expression , such as $(x + y)^n$. It is named for the 17th-century French mathematician Blaise Pascal, but it is far older.

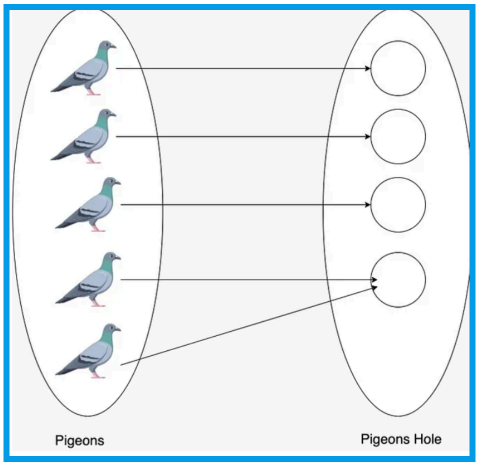


19. **permutations :** is a mathematical technique that determines the number of possible arrangements in a set when the order of the arrangements matters.

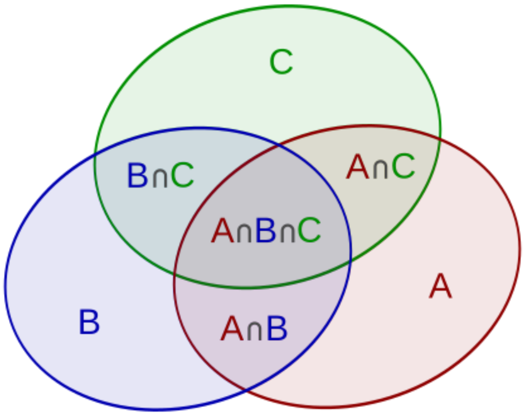
For example: the permutation of set A={1,6} is 2, such as {1,6}, {6,1}.

20. **pigeonhole principle :** states that if n items (pigeons) are put into m containers (holes) , with $n > m$, then at least one container must contain more than one item.

example: If you have 10 socks and only 9 drawers, at least one drawer must contain more than one sock.



21. **Principle of Inclusion-Exclusion :** is a method used to count the number of elements in the union of overlapping sets. It avoids over-counting elements that belong to multiple sets by systematically including and excluding intersections.



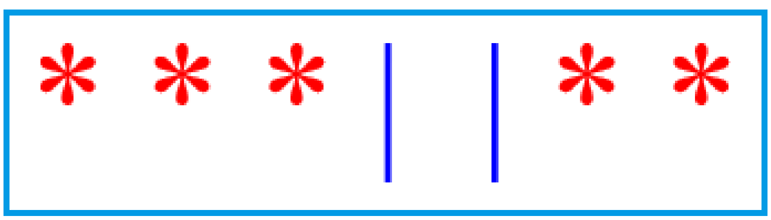
22. **Product :** the result of multiplication, or an expression that identifies objects (numbers or variables) to be multiplied, called *factors*. For example, 21 is the product of 3 and 7 (the result of multiplication)

$$\boxed{\Pi}$$

23. **restriction:** is a rule or condition that specifies how certain elements of a set must or must not be chosen, arranged, or related in a given context.

    Example:Arrange the letters in the word "CAT" such that the letter "C" is not in the first position.

24. **RHS :** is informal shorthand for the right-hand side of an equation.
25. **Stars and bars;** is a graphical aid for deriving certain combinatorial theorems. It can be used to solve many simple counting problems, such as how many ways there are to put n indistinguishable balls into k distinguishable bins .



26. **Sum :** summation is the addition of a sequence of numbers, called *addends* or *summands*; the result is their *sum* or *total*. Beside numbers, other types of values can be summed as well: functions, vectors, matrices, polynomials and, in general, elements of any type of mathematical objects on which an operation denoted "+" is defined.

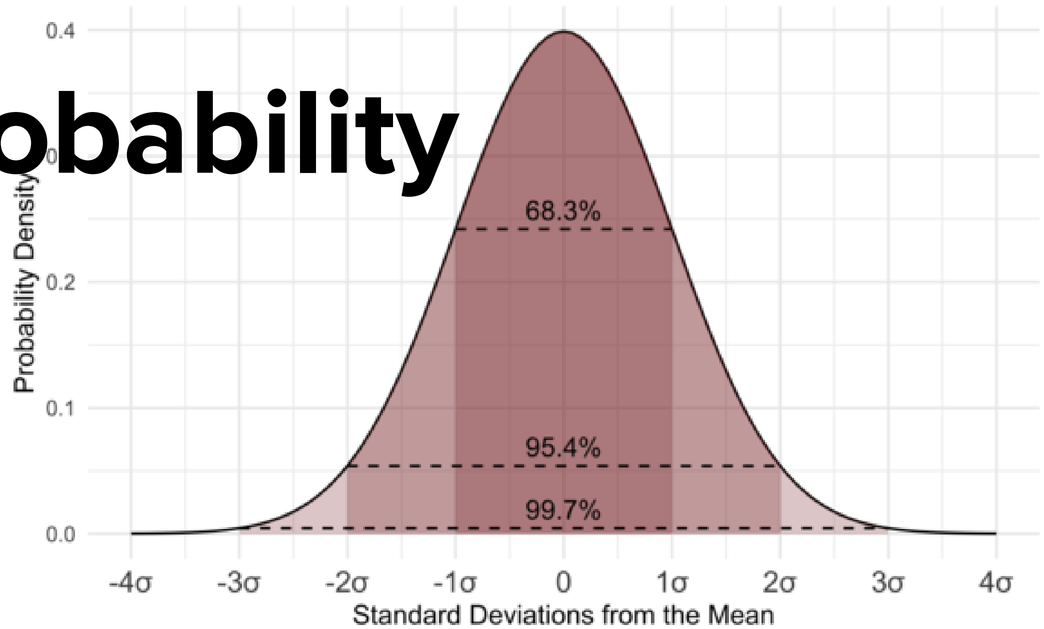
$$\boxed{\Sigma}$$

27. **With repetition :** refers to the ability to use the same element multiple times when forming arrangements, selections, or combinations.

 example: In a combination with repetition: choosing 3 scoops of ice cream from 5 flavors, where flavors can be repeated In a permutation with repetition: arranging the letters in the word "AAB," where 'A' repeats.

28. **without repetition :** means that each item or element can be selected only once in a particular arrangement or selection process.

Statistics And Introduction To probability



- Statistics is the discipline that concerns the collection, organization, analysis, interpretation, and presentation of data.[2] In applying statistics to a scientific, industrial, or social problem, it is conventional to begin with a statistical population or a statistical model to be studied.
- Probability is the branch of mathematics concerning events and numerical descriptions of how likely they are to occur. The probability of an event is a number between 0 and 1; the larger the probability, the more likely an event is to occur.

1. **Analysing data ;** the process of systematically collecting, cleaning, transforming, describing, modeling, and interpreting data, generally employing statistical techniques.
2. **Boundaries :** The *lower boundary* is the lower endpoint that determines the class interval; the upper boundary is the highest value.

   Example :

Height	Frequency
$155 \leq h < 165$	3
$165 \leq h < 175$	9
$175 \leq h < 185$	15
$185 \leq h < 195$	3
$195 \leq h < 205$	1

- The lower boundary of the $175 \leq h < 185$ class is 175 and the upper boundary is 185 .

3. **Central :** Anything *central* is in the middle of something — or essential to it. *Central* things are fundamental and important.
4. **Characteristics :** *qualities* or *features* that describe the distinctive nature or features of an individual organism or of a group.
5. **Class :** a set or category of things having some property or attribute in common and differentiated from others by kind, type, or quality

6. **Conditional distrbution :** A conditional distribution is a distribution of values for one variable that exists when you specify the values of other variables. This type of distribution allows you to assess the dispersal of your variable of interest under specific *conditions* .

Example :

$X \setminus Y$	A	B	C	Total
]0-5]	38	11	0	49
]5-10]	55	63	0	118
]10-15]	53	76	0	129
]15-20]	32	62	1	95
]20-25]	6	24	8	38
]25-30]	5	4	40	49
]30-35]	2	1	37	40
]35-40]	1	0	12	13
]40-45]	0	0	2	2
Total	192	241	100	533

7. **Correlation :** a mutual relationship or connection between two or more things.
8. **Data:** is a collection of discrete or continuous values that convey information, describing the quantity, quality, fact, statistics, other basic units of meaning, or simply sequences of symbols that may be further interpreted formally.

9. **Deviation :** the difference between the value of one number in a series of numbers and the average value of all the numbers in the series.
10. **Dependence** : the state of relying on or being controlled by someone or something else
11. **Descriptive :** presenting observations about the characteristics of someone or something : serving to describe .
12. **Distribution :** the action of sharing something out among a number of recipients.
13. **Discrete variable :** A discrete variable can only have a set of particular values. Only certain values are allowed, and none of the between values are. Discrete variables cover things that can be counted.

    example:

    The number of cars in a parking lot is a discrete variable, because we just count the cars. We don't count parts of cars

14. **Estimate :** an approximate calculation or judgement of the value, number, quantity, or extent of something.
15. **Frequency :** the **frequency** or **absolute frequency** of an event" i" is the number " ni " of times the observation has occurred/been recorded in an experiment or study.
16. **Independent variable** : free from outside control; not subject to another's authority.

    Example :

- someone's age might be an independent variable. Other factors (such as what they eat, how much they go to school, how much television they watch) aren't going to change a person's age.

17. **Inferential :** characterized by or involving conclusions reached on the basis of evidence and reasoning.

18. **Mean :** a quantity representing the "center" of a collection of numbers and is intermediate to the extreme values of the set of numbers .

Example :

What is the mean of 2, 4, 6, 8 and 10?

$$2 + 4 + 6 + 8 + 10 = 30$$

Now divide by 5 (total number of observations).

$$\text{Mean} = 30/5 = 6$$

19. **Measure :** a standard unit used to express the size, amount, or degree of something.

20. **Median :** The **median** of a set of numbers is the value separating the higher half from the lower half of a data sample, a population, or a probability distribution.

Example :

1, 3, 3, **6**, 7, 8, 9

Median = 6

1, 2, 3, **4**, **5**, 6, 8, 9

Median = (4 + 5) ÷ 2

= 4.5

Calculating the median in data sets of odd (above) and even (below) observations

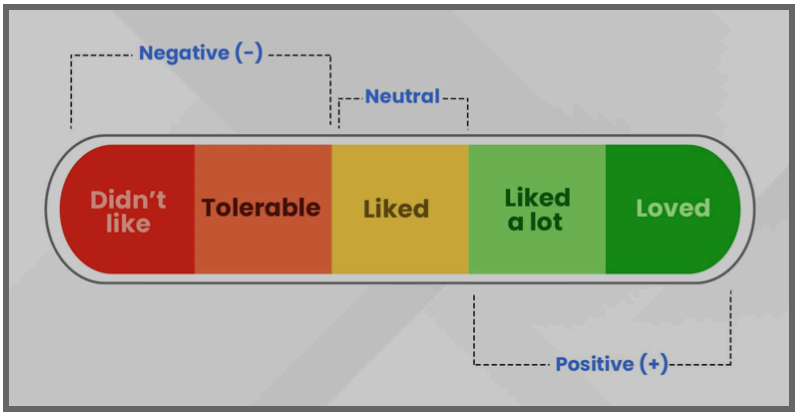
21. **Mode :** The mode of a sample is the element that occurs most often in the collection.

Example :

the mode of the sample [1, 3, 6, 6, 6, 6, 7, 7, 12, 12, 17] is 6. Given the list of data [1, 1, 2, 4, 4] its mode is not unique.

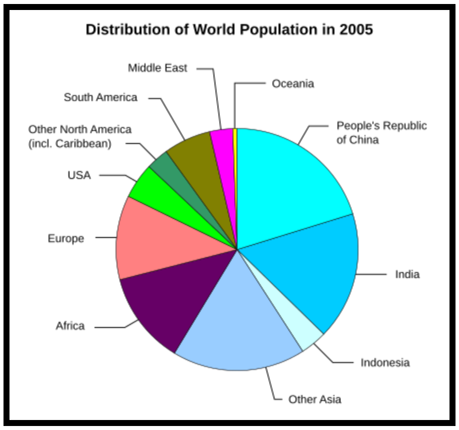
22. **Numerical :** relating to or expressed as a number or numbers.
23. **Observation :** a statement based on something one has seen, heard, or noticed.
24. **Ordinal data :** kind of qualitative data that groups variables into ordered categories. The categories have a natural order or rank based on some scale, like from high to low. But there is no clearly defined interval between the categories .

Example :



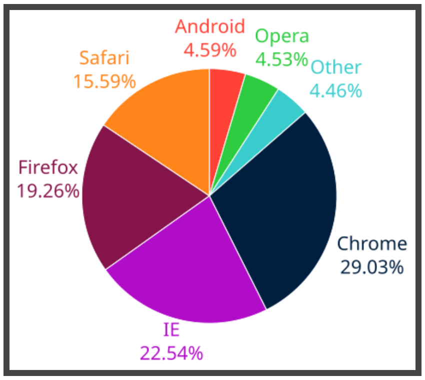
25. **Parameter :** is any quantity of a statistical population that summarizes or describes an aspect of the population, such as a mean or a standard deviation.

Example :



26. **Percentage :** a number or ratio expressed as a fraction of 100. It is often denoted using the percent sign (%) .

Example :



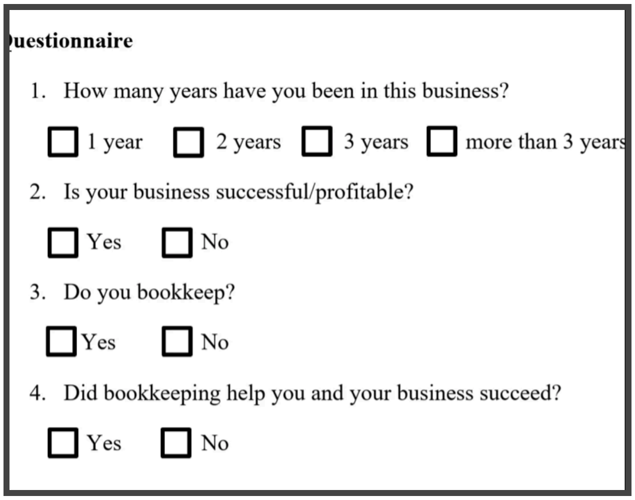
27. **Population :** is a set of similar items or events which is of interest for some question or experiment.[A statistical population can be a group of existing objects.

Example :

the set of all stars within the Milky Way galaxy .

28. **Questionnaire :** a set of printed or written questions with a choice of answers, devised for the purposes of a survey or statistical study.

Example :


uestionnaire

1. How many years have you been in this business?

☐ 1 year ☐ 2 years ☐ 3 years ☐ more than 3 years

2. Is your business successful/profitable?

☐ Yes ☐ No

3. Do you bookkeep?

☐ Yes ☐ No

4. Did bookkeeping help you and your business succeed?

☐ Yes ☐ No

29. **Randomness :** the apparent or actual lack of definite pattern or predictability in information.

Example :

- Flipping coins, rolling dice .

30. **Range :** a set of data is size of the narrowest interval which contains all the data. It is calculated as the difference between the largest and smallest values .

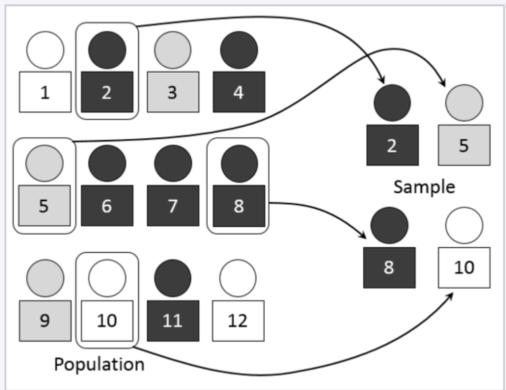
Example :

- if the given data set is {2,5,8,10,3}, then the range will be 10 – 2 = 8.

31. **Relationship :** The way in which two or more people or things are connected, or the state of being connected.

32.**Simple :** sampling is the selection of a subset or a statistical sample (termed sample for short) of individuals from within a statistical population to estimate characteristics of the whole population.

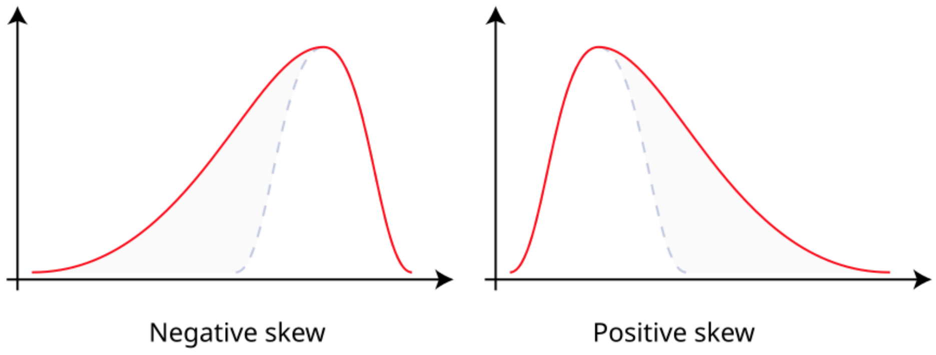
Example :



A visual representation of the sampling process

33.**Scale :** refer to ways in which variables/numbers are defined and categorized. Each scale of measurement has certain properties which in turn determines the appropriateness for use of certain statistical analyses. The four scales of measurement are nominal, ordinal, interval, and ratio.

34. **Skewness :** refers to the lack of symmetry in a data distribution, where one tail stretches further from the center than the other.



35. **Spread :** describe how similar or varied the set of observed values are for a particular variable (data item).

36. **Standard :** something set up and established by authority as a rule for the measure of quantity, weight, extent, value, or quality .

37. **Table of frequency** : a way of summarising a set of data. It is shown by a set of frequencies with a set of categories, intervals, or values into which a data set is classified. It can used to summarise qualitative or quantitative discrete data. It may also be used to summarise continuous data once the data set has been divided up into sensible groups.

example :

A Cumulative Frequency Table

Month	Number of toy cars sold (frequency)	Total number of toy cars sold (Cumulative frequency)
January	20	20
February	30	50
March	25	75
April	10	85
May	40	125
June	35	160

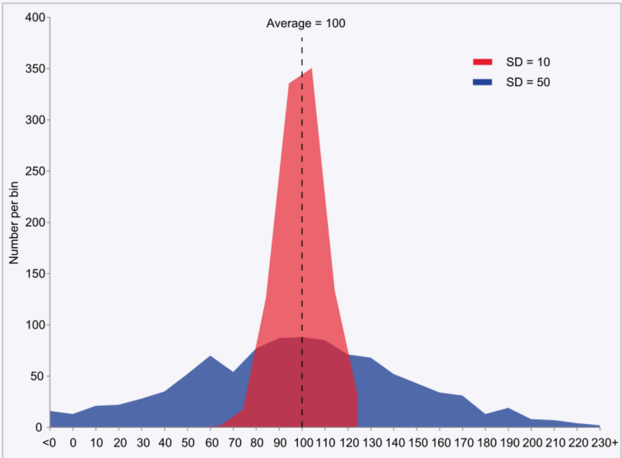
38. **Tendency** :an inclination towards a particular characteristic or type of behaviour.

39. **Variation :** a change or slight difference in condition, amount, or level, typically within certain limits.

Example : "regional variations in house prices"

40. Variance : a measure of dispersion, meaning it is a measure of how far a set of numbers is spread out from their average value.

Example :



Example of samples from two populations with the same mean but different variances. The red population has mean 100 and variance 100 (SD=10) while the blue population has mean 100 and variance 2500 (SD=50) where SD stands for Standard Deviation.