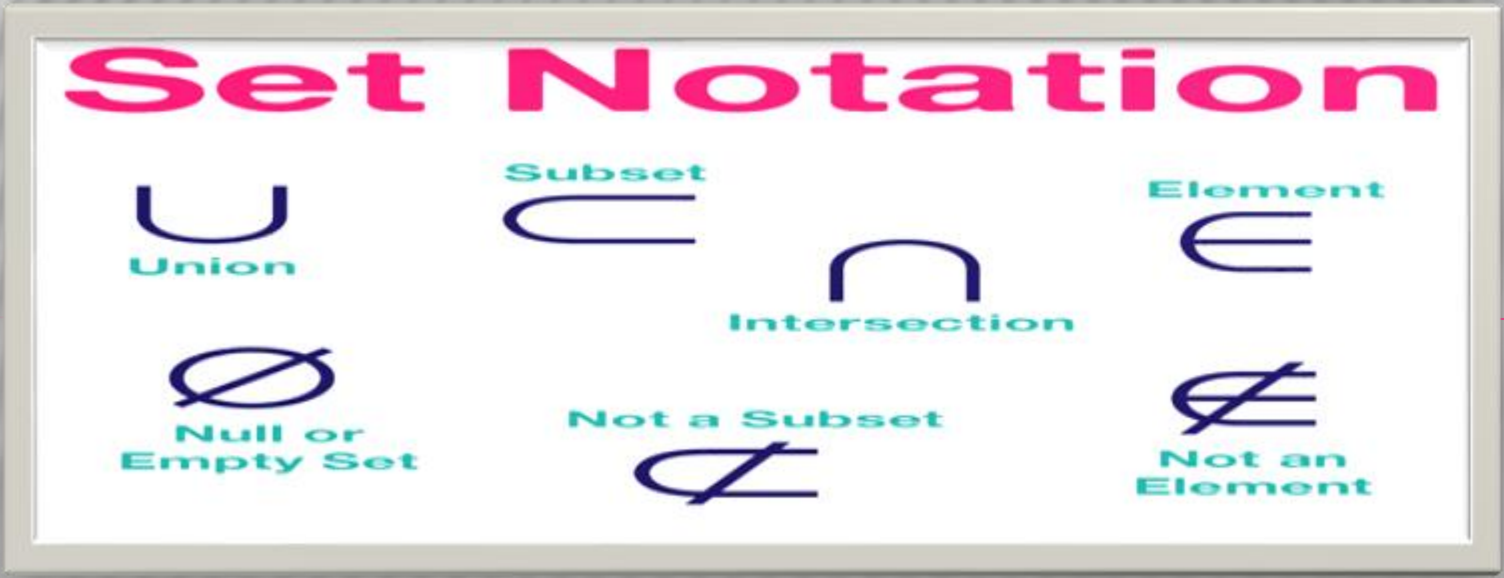
SETS

Sets are one of the most fundamental concepts in mathematics. A set is a collection of distinct objects, which can be anything like numbers, letters, shapes, fruits, animals, etc. The objects in a set are called elements or members of the set. For example, the set {a, b, c} has three elements: a, b, and c. We use curly brackets {} to write a set and separate the elements by commas.



Symbol	Symbol name	Meaning	Example
$\{\ \}$	set	a collection of elements	$A = \{3,7,9,14\}$, $B = \{9,14,28\}$
$\mid$	such that	so that	$A = \{x \mid x \in \mathbb{R}, x<0\}$
$A \cap B$	intersection	objects that belong to set A and set B	$A \cap B = \{9,14\}$
$A \cup B$	union	objects that belong to set A or set B	$A \cup B = \{3,7,9,14,28\}$
$A \subseteq B$	subset	subset has fewer elements or equal to the set	$\{9,14,28\} \subseteq \{9,14,28\}$
$A \subset B$	proper subset / strict subset	subset has fewer elements than the set	$\{9,14\} \subset \{9,14,28\}$
$A \not\subset B$	not subset	left set not a subset of right set	$\{9,66\} \not\subset \{9,14,28\}$
$A \supseteq B$	superset	set A has more elements or equal to the set B	$\{9,14,28\} \supseteq \{9,14,28\}$
$A \supset B$	proper superset / strict superset	set A has more elements than set B	$\{9,14,28\} \supset \{9,14\}$
$A \not\supset B$	not superset	set A is not a superset of set B	$\{9,14,28\} \not\supset \{9,66\}$
2^A	power set	all subsets of A	
$\mathcal{P}(A)$	power set	all subsets of A	

REPRESENTATION OF SETS

- Sets, in mathematics, are an organized collection of objects and can be represented in set-builder form or roster form. Usually, sets are represented in curly braces {}, for example, A = {1,2,3,4} is a set . In sets theory, you will learn about sets and their properties.
- There are three ways to represent a set:
- **Statement Form:** In statement form, the well-defined descriptions of a member of a set are written and enclosed in the curly brackets. For example, the set of even numbers less than 15. In statement form, it can be written as {even numbers less than 15}.
- **Roster Form:** In Roster form, all the elements of a set are listed. For example, the set of natural numbers less than 5. Natural Number = 1, 2, 3, 4, 5, 6, 7, 8,………. Natural Number less than 5 = 1, 2, 3, 4 Therefore, the set is N = { 1, 2, 3, 4 }.
- **Set Builder Form:** The general form is A = { x : property }. Example: Write the following sets in set builder form: A= {2, 4, 6, 8} Solution: A = {x : x = 2n where n is a natural number and n < 5}.

TYPES OF SETS

Sets can be classified into different types based on their properties. Some of the common types of sets are:

Empty set: A set that has no elements is called an empty set or a null set. It is denoted by the symbol Ø or {}. For example, the set of even numbers greater than 10 and less than 12 is an empty set.

Singleton set: A set that has only one element is called a singleton set or a unit set. For example, the set {x} has only one element x.

Finite set: A set that has a finite number of elements is called a finite set. For example, the set {1, 2, 3, 4, 5} has five elements and is a finite set.

Infinite set: A set that has an infinite number of elements is called an infinite set. For example, the set of natural numbers N = {1, 2, 3, ...} has infinitely many elements and is an infinite set.

Equal sets: Two sets are equal if they have exactly the same elements. For example, the sets {a, b, c} and {c, b, a} are equal because they have the same elements in different order.

TYPES OF SETS

Equivalent sets: Two sets are equivalent if they have the same number of elements. For example, the sets {a, b, c} and {x, y, z} are equivalent because they both have three elements.

Subset: A set A is a subset of another set B if every element of A is also an element of B. For example, the set {a, b} is a subset of the set {a, b, c}. We write $A \subseteq B$ to denote that A is a subset of B.

Proper subset: A set A is a proper subset of another set B if A is a subset of B and A is not equal to B. For example, the set {a, b} is a proper subset of the set {a, b, c}. We write $A \subset B$ to denote that A is a proper subset of B.

Superset: A set A is a superset of another set B if every element of B is also an element of A. For example, the set {a, b, c} is a superset of the set {a, b}. We write $A \supseteq B$ to denote that A is a superset of B.

Proper superset: A set A is a proper superset of another set B if A is a superset of B and A is not equal to B. For example, the set {a, b, c} is a proper superset of the set {a, b}. We write $A \supset B$ to denote that A is a proper superset of B.

Universal set: A universal set is a set that contains all the elements under consideration in a given context. For example, if we are talking about fruits, then the universal set could be the set of all fruits. It is usually denoted by the symbol U.

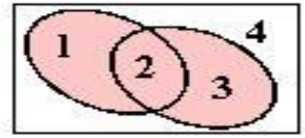
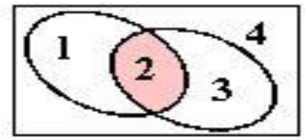
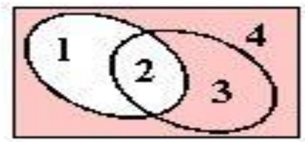
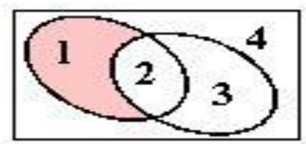
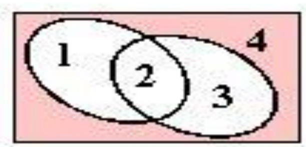
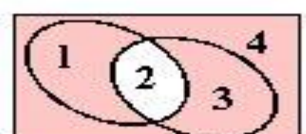
Power set: The power set of a given set A is the set of all possible subsets of A. For example, the power set of {a, b} is {{}, {a}, {b}, {a,b}}. It is denoted by P(A).

OPERATIONS ON SETS

- There are also some operations that can be performed on sets to create new sets. Some of the common operations are:
- ***Union:*** The union of two sets A and B is the set that contains all the elements that belong to either A or B or both. For example, the union of {a,b,c} and {c,d,e} is {a,b,c,d,e}. It is denoted by $A \cup B$.
- ***Intersection:*** The intersection of two sets A and B is the set that contains all the elements that belong to both A and B. For example, the intersection of {a,b,c} and {c,d,e} is {c}. It is denoted by $A \cap B$.

OPERATIONS ON SETS

- **Complement:** The complement of a set A with respect to a universal set U is the set that contains all the elements in U that are not in A. For example, if U = {1,2,...10}, then the complement of {2,4,...10} with respect to U is {1 ,3 ,5 ,7 ,9}. It is denoted by Ac or U - A.
- **Difference:** The difference of two sets A and B is the set that contains all the elements in A that are not in B. For example, the difference of {a,b,c} and {c,d,e} is {a,b}. It is denoted by A - B.
- **Cartesian product:** The Cartesian product of two sets A and B is the set of all ordered pairs (a,b) where a belongs to A and b belongs to B. For example, the Cartesian product of {1,2} and {a,b} is {(1,a), (1,b), (2,a), (2,b)}. It is denoted by A x B.

set notation	pronunciation	meaning	Venn diagram	answer
$A \cup B$	"A union B"	everything that is in either of the sets		{1, 2, 3}
$A \wedge B$ or $A \cap B$	"A intersect B"	only the things that are in both of the sets		{2}
A^c or $\sim A$	"A complement", or "not A"	everything in the universe outside of A		{3, 4}
$A - B$	"A minus B", or "A complement B"	everything in A except for anything in its overlap with B		{1}
$\sim(A \cup B)$	"not (A union B)"	everything outside A and B		{4}
$\sim(A \wedge B)$ or $\sim(A \cap B)$	"not (A intersect B)"	everything outside of the overlap of A and B		{1, 3, 4}

PROPERTIES OF SETS

- Sets are very useful in mathematics because they can be used to represent many concepts and structures, such as numbers, functions, relations, geometry, logic, probability, etc. Sets also have many properties and formulas that can be derived from the definitions and axioms of set theory. Some of the basic properties and formulas are:
- Commutative laws: $A \cup B = B \cup A$ and $A \cap B = B \cap A$
- Associative laws: $(A \cup B) \cup C = A \cup (B \cup C)$ and $(A \cap B) \cap C = A \cap (B \cap C)$
- Distributive laws: $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$ and $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$
- De Morgan's laws: $(A \cup B)c = Ac \cap Bc$ and $(A \cap B)c = Ac \cup Bc$
- Idempotent laws: $A \cup A = A$ and $A \cap A = A$
- Identity laws: $A \cup \{\} = A$ and $A \cap U = A$
- Complement laws: $Ac\ c = A$ and $Uc = \{\}$
- Absorption laws: $A \cup (A \cap B) = A$ and $A \cap (A \cup B) = A$
- Cardinality of union: $|A \cup B| = |A| + |B| - |A \cap B|$
- Cardinality of power set: $|P(A)| = 2|A|$
- Cardinality of Cartesian product: $|A \times B| = |A| \times |B|$