2026 EXAMINATION

CBSE

QUESTION & CONCEPT BANK

Chapter-wise & Topic-wise

CLASS 11

Chapter-wise
CONCEPT MAPS

Important terms, Formulae & Myth Buster
SMART SNAPS

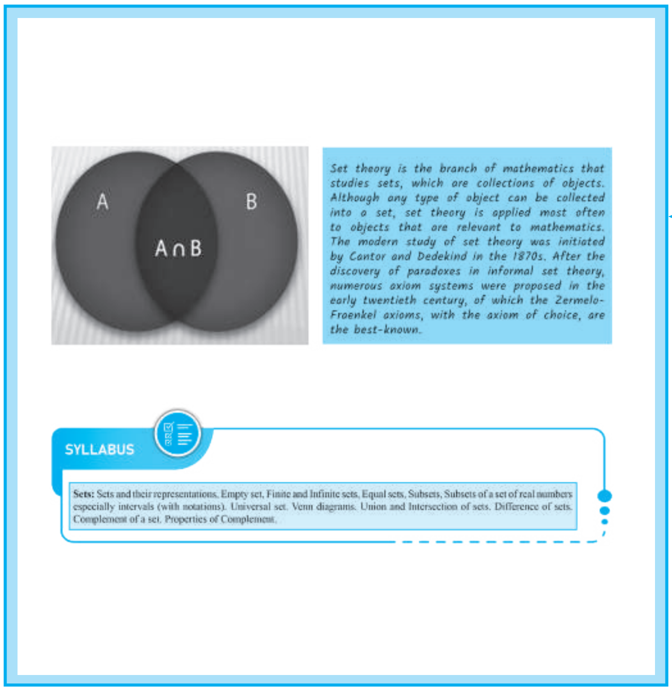
Revision Blue Print & Solved Questions
COMPETENCY FOCUSED

Important Questions with Detailed Explanations
POWER PRACTICE

MATHEMATICS

HOW TO USE THIS BOOK

This book is structured to support your learning journey of preparing for your board exams through a variety of engaging and informative elements. Here's how to make the most of it:



Set theory is the branch of mathematics that studies sets, which are collections of objects. Although any type of object can be collected into a set, set theory is applied most often to objects that are relevant to mathematics. The modern study of set theory was initiated by Cantor and Dedekind in the 1870s. After the discovery of paradoxes in informal set theory, numerous axiom systems were proposed in the early twentieth century, of which the Zermelo-Fraenkel axioms, with the axiom of choice, are the best-known.

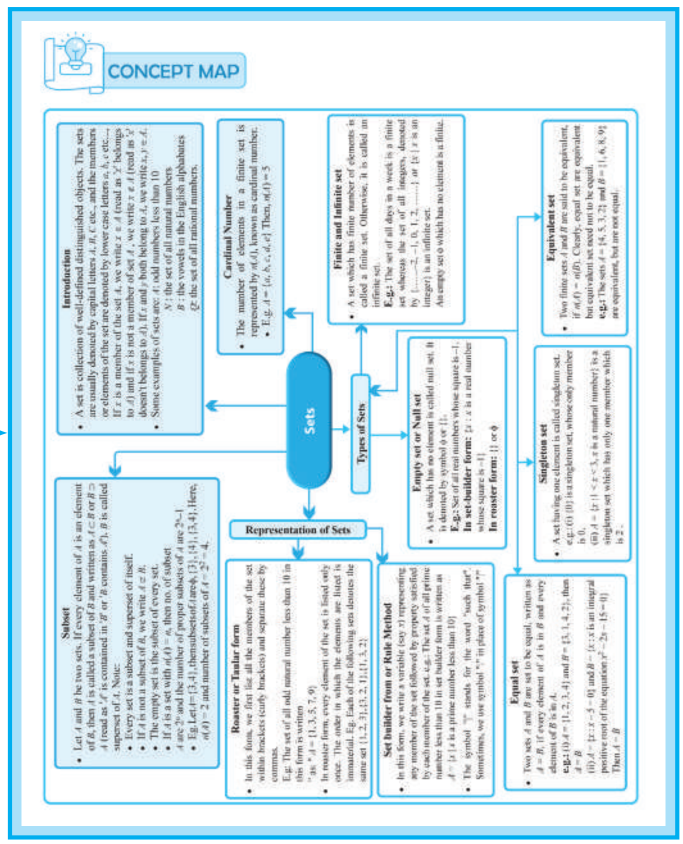
SYLLABUS

Sets: Sets and their representations. Empty set, Finite and Infinite sets, Equal sets, Subsets, Subsets of a set of real numbers especially intervals (with notations). Universal set. Venn diagrams. Union and Intersection of sets. Difference of sets. Complement of a set. Properties of Complement.

Preview

At the start of every chapter, you'll find a thoughtfully chosen image and a quote that captures the main idea and motivation of the topic. This approach aims to get your interest and give you a glimpse of the theme ahead.

Before diving into the details, we outline the syllabus. This helps you prioritize your study focus based on the significance of each section.



Concept Map

The concept map appears to be a comprehensive study aid that outlines key concepts in a structured format, featuring definitions, diagrams, and processes. For a student, it would serve as a visual summary, making complex ideas more accessible and aiding in revision and understanding of concept for their curriculum.

1 REPRESENTATION AND TYPES OF SETS

Important Terms

- **Set:** A well-defined collection of distinct objects, considered as a single object.
- **Element/Member:** An object that belongs to a set.
- **Roster Form:** A method of representing a set by listing its elements within curly braces, separated by commas.
- **Set-Builder Form:** A method of describing a set by stating the properties that its members must satisfy.
- **Empty Set** (ϕ)**:** A set that has no elements. It is also known as the null set.
- **Singleton Set:** A set containing exactly one element.
- **Finite Set:** A set that has a finite or countable number of elements.
- **Infinite Set:** A set that is not finite, meaning it has an uncountable number of elements.

Important Symbols

- $N \rightarrow$ The set of natural numbers.
- $Z \rightarrow$ The set of all integers.
- $Q \rightarrow$ The set of all rational numbers.
- $R \rightarrow$ The set of real numbers (rational and irrational numbers).
- $Z^{+} \rightarrow$ The set of positive integers.
- $Q^{+} \rightarrow$ The set of positive rational numbers.
- $R^{+} \rightarrow$ The set of positive real numbers (positive rational and numbers)
- $\in$ **(Element of):** Denotes that an object is an element of a set.
- $\notin$ **(Not an Element of):** Denotes that an object is not an element of a set.

Important Concepts

Set : a set is a well-defined collection of objects

If a is an element of a set A, we say that "a belongs to A" the Greek symbol $\in$ (epsilon) is used to denote the phrase 'belongs to'. Thus, we write $a \in A$. If 'b' is not an element of a set A, we write $b \notin A$ and read "b does not belong to A".

There are two methods of representing a set:

(i) Roster or tabular form

(ii) Set-builder form

In roster form, all the elements of a set are listed, the elements are being separated by commas and are enclosed within brackets { }. For example, the set of all even positive integers less than 7 is described in roster form as {2, 4, 6}.

In set-builder form, all the elements of a set possess a single common property which is not possessed by any element outside the set. For example, in the set {a, e, i, o, u}, all the elements possess a common property, namely, each of them is a vowel in the English alphabet, and no other letter possess this property. Denoting this set by V, we write $V = \{x : x \text{ is a vowel in English alphabet}\}$

Real Life Applications

1. **Data Analysis:** Sets are used to categorize and analyze data. For instance, customer segments in marketing are defined as sets with specific characteristics.
2. **Computer Science:** In computer programming, sets are used to manage collections of items like databases, arrays, and lists.
3. **Economics:** Economists use set theory to model different market scenarios and to predict economic behavior.
4. **Biology and Genetics:** In genetics, sets can represent different genotypes, alleles, or gene pools within a population.
5. **Logistics and Inventory Management:** Sets help in managing and organizing inventory by categorizing items, tracking stock levels, and identifying when items need to be reordered.
6. **Language and Literature:** In linguistics, sets can be used to define phonemes, morphemes, or syntax rules in a language.

Different Problem Types

Type I : Based on Representation of Sets

Ex. Which of the following are sets? Justify your answer.

(i) The collection of all the months of a year beginning with the letter J.

(ii) The collection of ten most talented writers of India.

(iii) A collection of novels written by the writer Munshi Prem Chand.

(iv) A collection of most dangerous animals of the world.

Sol. (i) We are sure that members of this collection are January, June and July.

So, this collection is well-defined. Hence, it is a set.

(ii) A writer may be most talented for one person and may not be for other. Therefore, we cannot definitely decide which writer will be there in the collection.

So, this collection is not well-defined. Hence, it is not a set.

(iii) Here, we can definitely decide whether a given novel is written by Munsi Prem Chand or not So, this collection is well-defined. Hence, it is a set.

Important Terms:

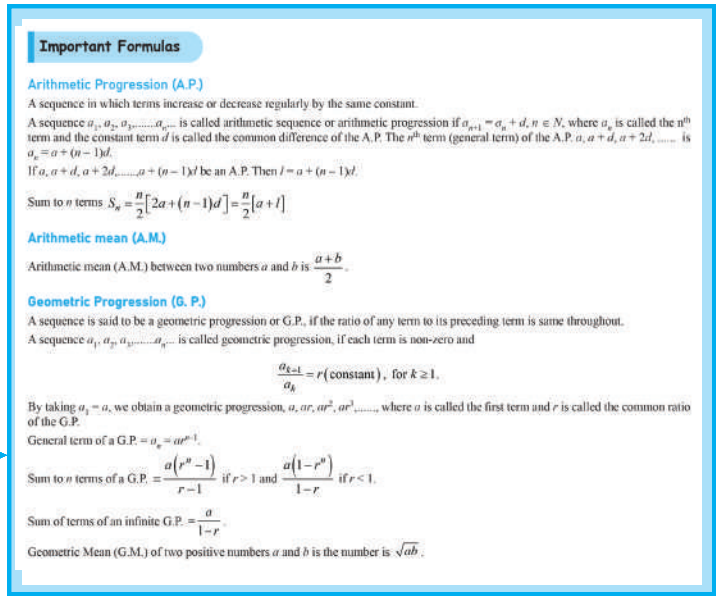
Important terms often serve as foundational concepts upon which more complex ideas are built. Introducing them early ensures students have a solid understanding before delving into more advanced topics.

Important Concepts:

Familiarizing with key concepts in advance helps prepare cognitive framework for processing and integrating new information. By highlighting important concepts upfront, students are better equipped to identify connections and relationships between various ideas presented in the chapter.

Important Formulas:

Introducing important formulas upfront brings clarity to the chapter's objectives, guiding students' focus towards essential mathematical principles that will be explored further.



Important Formulas

Arithmetic Progression (A.P.)

A sequence in which terms increase or decrease regularly by the same constant.

A sequence $a_1, a_2, a_3, \ldots\ldots a_n \ldots$ is called arithmetic sequence or arithmetic progression if $a_{n+1} = a_n + d, n \in N$, where a_n is called the n[th] term and the constant term d is called the common difference of the A.P. The n^{th} term (general term) of the A.P. $a, a+d, a+2d, \ldots\ldots$ is $a_n = a + (n-1)d$.

If $a, a+d, a+2d, \ldots\ldots, a+(n-1)d$ be an A.P. Then $l = a + (n-1)d$.

Sum to n terms $S_n = \frac{n}{2}\left[2a + (n-1)d\right] = \frac{n}{2}\left[a + l\right]$

Arithmetic mean (A.M.)

Arithmetic mean (A.M.) between two numbers a and b is $\frac{a+b}{2}$.

Geometric Progression (G. P.)

A sequence is said to be a geometric progression or G.P., if the ratio of any term to its preceding term is same throughout.

A sequence $a_1, a_2, a_3, \ldots\ldots a_n \ldots$ is called geometric progression, if each term is non-zero and

$$\frac{a_{k+1}}{a_k} = r\,(\text{constant}),\ \text{for } k \geq 1.$$

By taking $a_1 = a$, we obtain a geometric progression, $a, ar, ar^2, ar^3, \ldots\ldots$, where a is called the first term and r is called the common ratio of the G.P.

General term of a G.P. $= a_n = ar^{n-1}$.

Sum to n terms of a G.P. $= \frac{a(r^n - 1)}{r-1}$ if $r > 1$ and $\frac{a(1-r^n)}{1-r}$ if $r < 1$.

Sum of terms of an infinite G.P. $= \frac{a}{1-r}$.

Geometric Mean (G.M.) of two positive numbers a and b is the number is $\sqrt{ab}$.

Real Life Applications:

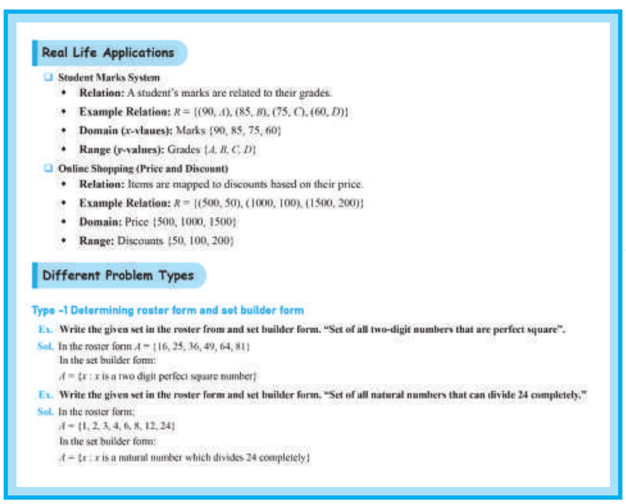
Connecting abstract math to real scenarios deepens comprehension and aids in problem-solving.

Learning how math connects with other subjects shows that it's useful in many areas and helps us understand different topics better.

Different Problem Types:

Presenting different types of problems encourages critical thinking and creativity by challenging students to approach each problem uniquely, analyse it, develop strategies, and adapt their approaches to find solutions.

Different problem types challenge students to analyse problems from diverse angles, fostering critical thinking skills essential for problem-solving.



Real Life Applications

- **Student Marks System**
  - **Relation:** A student's marks are related to their grades.
  - **Example Relation:** $R = \{(90, A), (85, B), (75, C), (60, D)\}$
  - **Domain (x-vlaues):** Marks {90, 85, 75, 60}
  - **Range (y-values):** Grades {A, B, C, D}
- **Online Shopping (Price and Discount)**
  - **Relation:** Items are mapped to discounts based on their price.
  - **Example Relation:** $R = \{(500, 50), (1000, 100), (1500, 200)\}$
  - **Domain:** Price {500, 1000, 1500}
  - **Range:** Discounts {50, 100, 200}

Different Problem Types

Type -1 Determining roster form and set builder form

Ex. Write the given set in the roster from and set builder form. "Set of all two-digit numbers that are perfect square".

Sol. In the roster form $A = \{16, 25, 36, 49, 64, 81\}$

In the set builder form:

$A = \{x : x \text{ is a two digit perfect square number}\}$

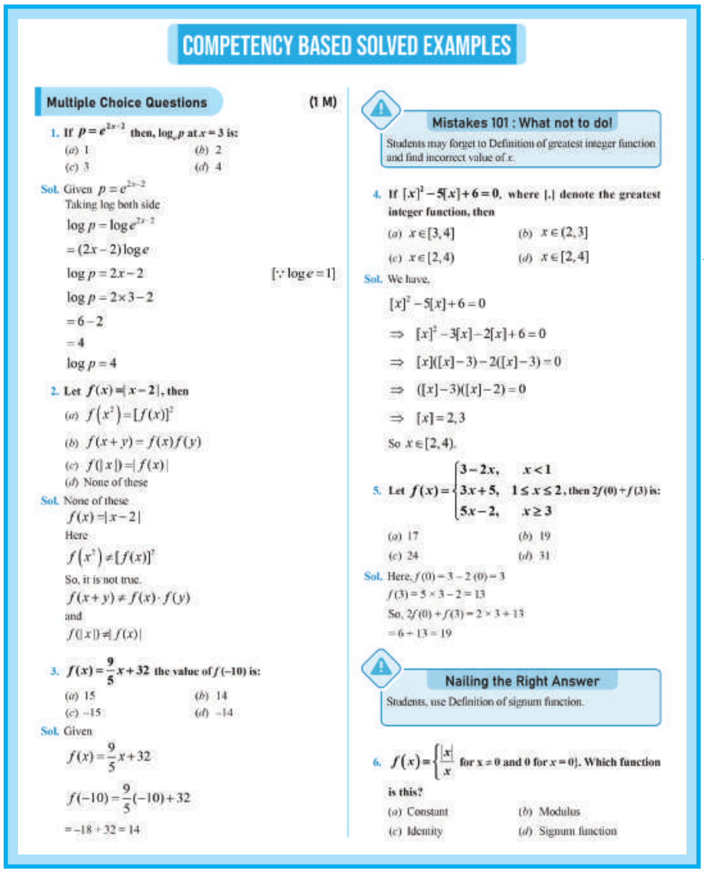
Ex. Write the given set in the roster form and set builder form. "Set of all natural numbers that can divide 24 completely."

Sol. In the roster form:

$A = \{1, 2, 3, 4, 6, 8, 12, 24\}$

In the set builder form:

$A = \{x : x \text{ is a natural number which divides 24 completely}\}$



COMPETENCY BASED SOLVED EXAMPLES

Multiple Choice Questions (1 M)

1. If $p = e^{2x-2}$ then, $\log_e p$ at $x = 3$ is:
   (a) 1 (b) 2
   (c) 3 (d) 4

Sol. Given $p = e^{2x-2}$
Taking log both side
$\log p = \log e^{2x-2}$
$= (2x-2)\log e$
$\log p = 2x - 2$ $[\because \log e = 1]$
$\log p = 2 \times 3 - 2$
$= 6 - 2$
$= 4$
$\log p = 4$

2. Let $f(x) = |x-2|$, then
   (a) $f(x^2) = [f(x)]^2$
   (b) $f(x+y) = f(x)f(y)$
   (c) $f(|x|) = |f(x)|$
   (d) None of these

Sol. None of these
$f(x) = |x-2|$
Here
$f(x^2) \neq [f(x)]^2$
So, it is not true.
$f(x+y) \neq f(x) \cdot f(y)$
and
$f(|x|) \neq |f(x)|$

3. $f(x) = \frac{9}{5}x + 32$ the value of $f(-10)$ is:
   (a) 15 (b) 14
   (c) −15 (d) −14

Sol. Given
$f(x) = \frac{9}{5}x + 32$
$f(-10) = \frac{9}{5}(-10) + 32$
$= -18 + 32 = 14$

Mistakes 101 : What not to do!
Students may forget to Definition of greatest integer function and find incorrect value of x.

4. If $[x]^2 - 5[x] + 6 = 0$, where [.] denote the greatest integer function, then
   (a) $x \in [3, 4]$ (b) $x \in (2, 3]$
   (c) $x \in [2, 4)$ (d) $x \in [2, 4]$

Sol. We have,
$[x]^2 - 5[x] + 6 = 0$
$\Rightarrow [x]^2 - 3[x] - 2[x] + 6 = 0$
$\Rightarrow [x]([x]-3) - 2([x]-3) = 0$
$\Rightarrow ([x]-3)([x]-2) = 0$
$\Rightarrow [x] = 2, 3$
So $x \in [2, 4)$.

5. Let $f(x) = \begin{cases} 3-2x, & x < 1 \\ 3x+5, & 1 \le x \le 2 \\ 5x-2, & x \ge 3 \end{cases}$, then $2f(0) + f(3)$ is:
   (a) 17 (b) 19
   (c) 24 (d) 31

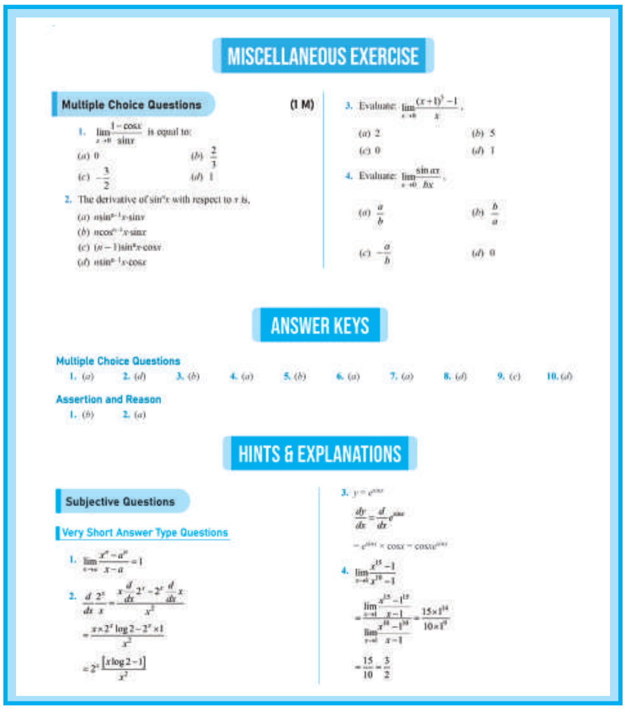
Sol. Here, $f(0) = 3 - 2(0) = 3$
$f(3) = 5 \times 3 - 2 = 13$
So, $2f(0) + f(3) = 2 \times 3 + 13$
$= 6 + 13 = 19$

Nailing the Right Answer
Students, use Definition of signum function.

6. $f(x) = \left\{\frac{|x|}{x}\right.$ for $x \neq 0$ and 0 for $x = 0\}$. Which function is this?
   (a) Constant (b) Modulus
   (c) Identity (d) Signum function

Solved Examples

For each topic, solved examples are provided that exemplify how to approach and solve questions. This section is designed to reinforce your learning and improve problemsolving skills.



MISCELLANEOUS EXERCISE

Multiple Choice Questions (1 M)

1. $\lim_{x \to 0} \frac{1 - \cos x}{\sin x}$ is equal to:
   (a) 0 (b) $\frac{2}{3}$
   (c) $-\frac{3}{2}$ (d) 1

2. The derivative of $\sin^n x$ with respect to x is,
   (a) $n\sin^{n-1}x \cdot \sin x$
   (b) $n\cos^{n-1}x \cdot \sin x$
   (c) $(n-1)\sin^n x \cdot \cos x$
   (d) $n\sin^{n-1}x \cdot \cos x$

3. Evaluate: $\lim_{x \to 0} \frac{(x+1)^5 - 1}{x}$.
   (a) 2 (b) 5
   (c) 0 (d) 1

4. Evaluate: $\lim_{x \to 0} \frac{\sin ax}{bx}$.
   (a) $\frac{a}{b}$ (b) $\frac{b}{a}$
   (c) $-\frac{a}{b}$ (d) 0

ANSWER KEYS

Multiple Choice Questions
1. (a) 2. (d) 3. (b) 4. (a) 5. (b) 6. (a) 7. (a) 8. (d) 9. (c) 10. (d)

Assertion and Reason
1. (b) 2. (a)

HINTS & EXPLANATIONS

Subjective Questions

Very Short Answer Type Questions

1. $\lim_{x \to a} \frac{x^n - a^n}{x - a} = 1$

2. $\frac{d}{dx}\frac{2^x}{x} = \frac{x\frac{d}{dx}2^x - 2^x\frac{d}{dx}x}{x^2}$
$= \frac{x \times 2^x \log 2 - 2^x \times 1}{x^2}$
$= 2^x \frac{[x \log 2 - 1]}{x^2}$

3. $y = e^{\sin x}$
$\frac{dy}{dx} = \frac{d}{dx}e^{\sin x}$
$= e^{\sin x} \times \cos x = \cos x e^{\sin x}$

4. $\lim_{x \to 1} \frac{x^{15} - 1}{x^{10} - 1}$
$= \frac{\lim_{x \to 1}\frac{x^{15} - 1^{15}}{x - 1}}{\lim_{x \to 1}\frac{x^{10} - 1^{10}}{x - 1}} = \frac{15 \times 1^{14}}{10 \times 1^9}$
$= \frac{15}{10} = \frac{3}{2}$

Answer Key

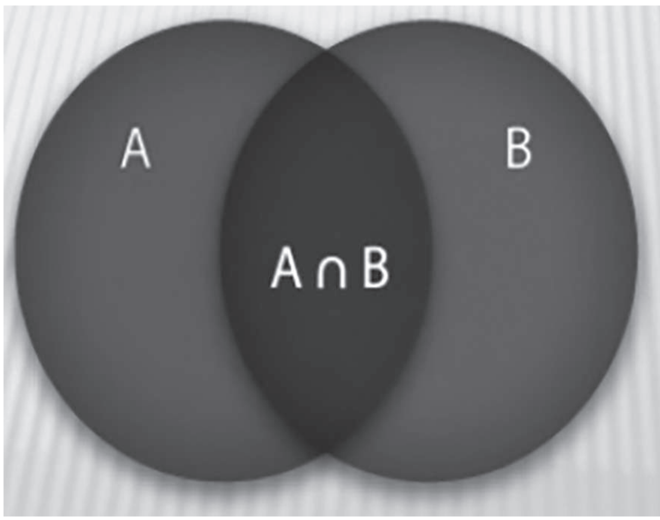
At the end of each chapter, you'll find additional exercises intended to test your grasp of the material. These are great for revision and to prepare for exams.

Answer Key and Explanations including Mistake 101, Nailing the right answer.

CONTENTS

SETS

1



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SYLLABUS

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CONCEPT MAP

Sets

Introduction
- A set is collection of well-defined distinguished objects. The sets are usually denoted by capital letters A, B, C etc., and the members or elements of the set are denoted by lower case letters a, b, c etc..., If x is a member of the set A, we write $x \in A$ (read as 'x' belongs to A) and if x is not a member of set A, we write $x \notin A$ (read as 'x' doesn't belongs to A). If x and y both belong to A, we write $x, y \in A$.
- Some examples of sets are: A: odd numbers less than 10
  N : the set of all natural numbers
  B : the vowels in the English alphabates
  Q: the set of all rational numbers.

Cardinal Number
- The number of elements in a finite set is represented by $n(A)$, known as cardinal number.
  - E.g. $A = \{a, b, c, d, e\}$ Then, $n(A) = 5$

Subset
- Let A and B be two sets. If every element of A is an element of B, then A is called a subset of B and written as $A \subset B$ or $B \supset A$ (read as 'A' is contained in 'B' or 'B contains A'). B is called superset of A. Note:
  - Every set is a subset and superset of itself.
  - If A is not a subset of B, we write $A \not\subset B$.
  - The empty set is the subset of every set.
  - If A is a set with $n(A) = n$, then no. of subset A are 2^n and the number of proper subsets of A are $2^n–1$
  - Eg. Let $A = \{3,4\}$, then subsets of A are $\phi, \{3\}, \{4\}, \{3,4\}$. Here, $n(A) = 2$ and number of subsets of $A = 2^2 = 4$.

Representation of Sets

Roaster or Taular form
- In this form, we first list all the members of the set within brackets (curly brackets) and separate these by commas.
  E.g: The set of all odd natural number less than 10 in this form is written
  " as: " $A = \{1, 3, 5, 7, 9\}$
- In roaster form, every element of the set is listed only once. The order in which the elements are listed is immaterial. Eg. Each of the following sets denotes the same set $\{1, 2, 3\}, \{3, 2, 1\}, \{1, 3, 2\}$

Set builder from or Rule Method
- In this form, we write a variable (say x) representing any member of the set followed by property satisfied by each member of the set. e.g.: The set A of all prime number less than 10 in set builder form is written as $A = \{x \mid x$ is a prime number less than $10\}$
- The symbol "|" stands for the word "such that". Sometimes, we use symbol ":" in place of symbol "|"

Types of Sets

Finite and Infinite set
- A set which has finite number of elements is called a finite set. Otherwise, it is called an infinite set.
  E.g.: The set of all days in a week is a finite set whereas the set of all integers, denoted by $\{......–2, –1, 0, 1, 2, ...\}$ or $\{x \mid x$ is an integer$\}$ is an infinite set.
  An empty set ϕ which has no element is a finite.

Empty set or Null set
- A set which has no element is called null set. It is denoted by symbol ϕ or $\{\}$.
  E.g.: Set of all real numbers whose square is –1.
  In set-builder form: $\{x : x$ is a real number whose square is $–1\}$
  In roaster form: $\{\}$ or ϕ

Equal set
- Two sets A and B are set to be equal, written as $A = B$, if every element of A is in B and every element of B is in A.
  e.g.: (i) $A = \{1, 2, 3, 4\}$ and $B = \{3, 1, 4, 2\}$, then $A = B$
  (ii) $A = \{x : x – 5 = 0\}$ and $B = \{x : x$ is an integral positive root of the equation $x^2 – 2x – 15 = 0\}$
  Then $A = B$

Singleton set
- A set having one element is called singleton set.
  e.g.: (i) $\{0\}$ is a singleton set, whose only member is 0.
  (ii) $A = \{x : 1 < x < 3, x$ is a natural number$\}$ is a singleton set which has only one member which is 2 .

Equivalent set
- Two finite sets A and B are said to be equivalent, if $n(A) = n(B)$. Clearly, equal set are equivalent but equivalent set need not to be equal.
  e.g.: The sets $A = \{4, 5, 3, 2\}$ and $B = \{1, 6, 8, 9\}$ are equivalent, but are not equal.

Sets

Power Set

- The set of all subset of a given set A is called **power set** of A and denoted by $P(A)$.
  E.g.: If $A = \{1, 2, 3\}$, then $P(A) = \{\phi, \{1\}, \{2\}, \{3\}, \{1, 2\}, \{1, 3\}, \{2, 3\}, \{1, 2, 3\}\}$.
  Clearly, if A has n elements, then its power set $P(A)$ contains exactly 2^n elements.

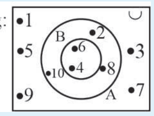
Universal Set

- The set containing all objects of element and of which all other sets are subsets is known as universal sets and denoted by U.
  E.g : For the set of all intergers, the universal set can be the set of rational numbers or the set R of real numbers

Venn Diagram

- A Venn diagram is an illustration of the relationships between and among sets, groups of objects that share something common These diagrams consist of rectangle and closed curves usually circles

Eg:



In the given venn diagram $U = \{1, 2, 3, \ldots 10\}$ universe set of which $A = \{2, 4, 6, 8, 10\}$ and $B = \{4, 6\}$ are subsets and also $B \subset A$

Complement of Sets

- If U is a universal set and A is a subset of U, then complement of A is the set which contains those elements of U, which are not present in A and is denoted by A' or A^C. Thus, $A^C = \{x : x \in U$ and $x \notin A\}$e.g.: If $U = \{1, 2, 3, 4, \ldots\}$ and $A = \{2, 4, 6, 8, \ldots\}$ then $A^C = \{1, 3, 5, 7, \ldots\}$

Algera of Sets

- For any set A, we have
  (a) $A \cup A = A$, (b) $A \cap A = A$, (c) $A \cup \phi = A$, (d) $A \cap \phi = \phi$, (e) $A \cup U = U$ (f) $A \cap U = A$, (g) $A - \phi = A$, (h) $A - A = \phi$
- For any two sets A and B we have
  (a) $A \cup B = B \cup A$, (b) $A \cap B = B \cap A$, (c) $A - B \subseteq A$, (d) $B - A \subseteq B$
- For any three sets A, B and C, we have
  (a) $A \cup (B \cup C) = (A \cup B) \cup C$
  (b) $A \cap (B \cap C) = (A \cap B) \cap C$
  (c) $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$,
  (d) $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$
  (e) $A - (B \cup C) = (A - B)) \cap (A - C)$,
  (f) $A - (B \cap C) = (A - B) \cup (A - C)$

Sets

Operations on Sets

Complement law:

(i) $A \cup A' = U$ (ii) $A \cap A' = \phi$

- De morgan's Law:
  (i) $(A \cup B)' = A' \cap B'$
  (ii) $(A \cap B)' = A' \cup B'$
- Double Complement law:
  $(A')' = A$
- Law of empty set and universal set.
  $\phi' = U$ and $U' = \phi$

Union

- The union of two sets A and B, written as $A \cup B$ (read as A union B) is the set of all elements which are either in A or in B in both. Thus, $A \cup B = \{x : x \in A$ or $x \in B\}$ clearly, $x \in A \cup B \Rightarrow x \in A$ or $x \in B$ and $x \notin A \cup B \Rightarrow x \notin A$ and $x \notin B$

eg: If $A = \{a, b, c, d\}$ and $B = \{c, d, e, f\}$ then $A \cup B = \{a, b, c, d, e, f\}$

Difference of two Sets

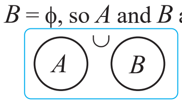
Subsets of a set of real numbers 'R'

- The set of natural numbers
  $N = \{1, 2, 3, 4, 5, \ldots\ldots\ldots\}$
- The set of integers
  $Z = \{\ldots. -3, -2, 1, 0, 1, 2, 3, \ldots\}$
- The set of irrational number
  $T = \{x : x \in R$ and $x \notin Q\}$
- The set of rational number
  $Q = \{x : x = \frac{p}{q}$ $p, q \in Z$ and $q \neq 0\}$

Relation among these subsets are
$N \subset Z \subset Q$, $Q \subset R$, $T \subset R$, $N \not\subset T$

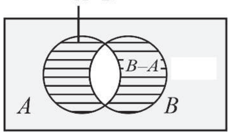
Disjoint Sets

Two sets A and B are said to be disjoint, if $A \cap B = \phi$ i.e, A and B have no common elements eg: if $A = \{1, 3, 5\}$ and $B = \{2, 4, 6\}$. Then, $A \cap B = \phi$, so A and B are disjoint.



Difference of sets

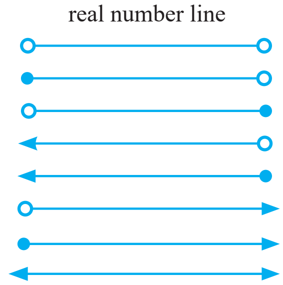
- If A and B are two sets, then their difference A-B is defined as:
  $A - B = \{x : x \in A$ and $x \notin B\}$
  Similarly, $B - A = \{x : x \in B$ and $x \notin A\}$
  Eg. If $A = \{1, 2, 3, 4, 5,\}$ and $B = \{1, 3, 5, 7, 9\}$ then $A - B = \{2, 4\}$ and $B - A = \{7, 9\}$



Interval Notation'

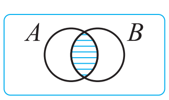
Let a and b real numbers with $a < b$

Set of Real Numbers	Interval Notation	Region of the real number line
• $\{x \mid a < x < b\}$	(a, b)	
• $\{x \mid a \leq x < b\}$	$[a, b)$	
• $\{x \mid a < x \leq b\}$	$(a, b]$	
• $\{x \mid x < b\}$	$(-\infty, b)$	
• $\{x \mid x \leq b\}$	$(-\infty, b]$	
• $\{x \mid x > a\}$	(a, ∞)	
• $\{x \mid x \geq a\}$	$[a, \infty)$	
• R	$(-\infty, \infty)$	



Intersection

The intersection of two sets A and B, written as $A \cap B$ (read as 'A' intersection 'B') is the set consisting of all the common elements of A and B.
Thus, $A \cap B = \{x : x\ A \in$and $x \in B\}$
Clearly, $x \in A \cap B \Rightarrow \{x \in A$ and $x \in B\}$ and $x \notin A \cap B \Rightarrow \{x \notin A$ or $x \notin B\}$
Eg: If $A = \{a, b, c, d\}$ and $= \{c, d, e f\}$
Then $A \cap B = \{c, d\}$



1 REPRESENTATION AND TYPES OF SETS

Important Terms

- **Set:** A well-defined collection of distinct objects, considered as a single object.
- **Element/Member:** An object that belongs to a set.
- **Roster Form:** A method of representing a set by listing its elements within curly braces, separated by commas.
- **Set-Builder Form:** A method of describing a set by stating the properties that its members must satisfy.
- **Empty Set (ϕ):** A set that has no elements. It is also known as the null set.
- **Singleton Set:** A set containing exactly one element.
- **Finite Set:** A set that has a finite or countable number of elements.
- **Infinite Set:** A set that is not finite, meaning it has an uncountable number of elements.

Important Symbols

- $N \rightarrow$ The set of natural numbers.
- $Z \rightarrow$ The set of all integers.
- $Q \rightarrow$ The set of all rational numbers.
- $R \rightarrow$ The set of real numbers (rational and irrational numbers).
- $Z^+ \rightarrow$ The set of positive integers.
- $Q^+ \rightarrow$ The set of positive rational numbers.
- $R^+ \rightarrow$ The set of positive real numbers (positive rational and numbers)
- $\in$ **(Element of):** Denotes that an object is an element of a set.
- $\notin$ **(Not an Element of):** Denotes that an object is not an element of a set.

Important Concepts

Set : a set is a well-defined collection of objects

If a is an element of a set A, we say that "a belongs to A" the Greek symbol $\in$ (epsilon) is used to denote the phrase 'belongs to'. Thus, we write $a \in A$. If 'b' is not an element of a set A, we write $b \notin A$ and read "b does not belong to A".

There are two methods of representing a set:

(i) Roster or tabular form

(ii) Set-builder form.

In roster form, all the elements of a set are listed, the elements are being separated by commas and are enclosed within brackets { }. For example, the set of all even positive integers less than 7 is described in roster form as {2, 4, 6}.

In set-builder form, all the elements of a set possess a single common property which is not possessed by any element outside the set. For example, in the set $\{a, e, i, o, u\}$, all the elements possess a common property, namely, each of them is a vowel in the English alphabet, and no other letter possess this property. Denoting this set by V, we write $V = \{x : x$ is a vowel in English alphabet$\}$

Real Life Applications

1. **Data Analysis:** Sets are used to categorize and analyze data. For instance, customer segments in marketing are defined as sets with specific characteristics.
2. **Computer Science:** In computer programming, sets are used to manage collections of items like databases, arrays, and lists.
3. **Economics:** Economists use set theory to model different market scenarios and to predict economic behavior.
4. **Biology and Genetics:** In genetics, sets can represent different genotypes, alleles, or gene pools within a population.
5. **Logistics and Inventory Management:** Sets help in managing and organizing inventory by categorizing items, tracking stock levels, and identifying when items need to be reordered.
6. **Language and Literature:** In linguistics, sets can be used to define phonemes, morphemes, or syntax rules in a language.

Different Problem Types

Type I : Based on Representation of Sets

Ex. Which of the following are sets? Justify your answer.

(i) The collection of all the months of a year beginning with the letter J.

(ii) The collection of ten most talented writers of India.

(iii) A collection of novels written by the writer Munshi Prem Chand.

(iv) A collection of most dangerous animals of the world.

Sol. (i) We are sure that members of this collection are January, June and July.

So, this collection is well-defined. Hence, it is a set.

(ii) A writer may be most talented for one person and may not be for other. Therefore, we cannot definitely decide which writer will be there in the collection.

So, this collection is not well-defined. Hence, it is not a set.

(iii) Here, we can definitely decide whether a given novel is written by Munsi Prem Chand or not So, this collection is well-defined. Hence, it is a set.

COMPETENCY BASED SOLVED EXAMPLES

Multiple Choice Questions (1 M)

1. **Empty set is a _______.**
(*a*) Infinite set (*b*) Finite set
(*c*) Unknown set (*d*) Universal set

Sol. The cardinality of the empty set is zero, since it has no elements. Hence, the size of the empty set is zero.

2. **Write $X = \{1, 4, 9, 16, 25, ...\}$ in set builder form.**
(*a*) $X = \{x : x$ is a prime number$\}$
(*b*) $X = \{x : x$ is a whole number$\}$
(*c*) $X = \{x : x$ is a natural number$\}$
(*d*) $X = \{x : x \in N, x$ is a square number$\}$

Sol. Given,
$X = \{1, 4, 9, 16, 25, ...\}$
$X = \{1^2, 2^2, 3^2, 4^2, 5^2, ...\}$
Therefore,
$X = \{x : x \in N, x$ is a set of square numbers$\}$

3. **The set $\{x : x$ is an even prime number$\}$ can be written as**
(*a*) $\{2\}$ (*b*) $\{2, 4\}$
(*c*) $\{2, 14\}$ (*d*) $\{2, 4, 14\}$

Sol. The given set = $\{2\}$

4. **Which of the following collections are sets?**
(*a*) The collection of all the days of a week
(*b*) A collection of 11 best hockey player of India.
(*c*) The collection of all rich person of Delhi
(*d*) A collection of most dangerous animals of India.

Sol. The days of a week are well defined.
Hence, the collection of all the days of a week, is a set.

5. **If ϕ denotes the empty set, then which one of the following is correct?**
(*a*) $\phi \in \phi$ (*b*) $\phi \in \{\phi\}$
(*c*) $\{\phi\} \in \{\phi\}$ (*d*) $0 \in \phi$

Sol: Since, ϕ is an empty set, $\phi \in \{\phi\}$

Mistakes 101 : What not to do!

Students ϕ represents the empty null set. No bracket is to be used with 'ϕ' symbol.

6. **Which one of the following is an infinite set?**
(*a*) The set of human beings on the earth
(*b*) The set of water drops in a glass of water
(*c*) The set of trees in a forest
(*d*) The set of all primes

Sol: In the given sets, the set of all primes is an infinite set.

Answer Key

1. (*b*) 2. (*d*) 3. (*a*) 4. (*a*) 5. (*b*)
6. (*d*)

Assertion and Reason (1 M)

Direction: **In each of the following questions, a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as**

(*a*) Both assertion and reason are true, and reason is the correct explanation of assertion.
(*b*) Both assertion and reason are true, but reason is not the correct explanation of assertion.
(*c*) Assertion is true, but reason is false.
(*d*) Assertion is false, but reason is true

1. **Assertion (A): The set $D = \{x : x$ is a prime number which is a divisor of 60$\}$**

Reason (R): The roster form of prime number which is divisor of 60 is $\{1, 2, 3, 4, 5\}$.

Sol: Reason is not true

2. **Assertion: The empty set is a subset of every set.**

Reason: By definition, the empty set has no elements, so it is a subset of any set.

Sol: Both assertion and reason are true and reason is the correct explanation of assertion.

3. **Assertion (A): The set $D = \{x$: x is even prime number$\}$ in roster form is $\{2,3\}$.**

Reason (R): The set E = the set of all letters in the word: 'SCHOOL', in the roster form is {S, C, H, O, L}.

Sol: We can see that 2 is the only even prime number here. So, $D = \{x$: x is even prime number$\} = 2$
Thus, the given roster form of set D is wrong.
There are 6 letters in the word 'SCHOOL' out of which letter O is repeated. Hence, set E in the roster form is $\{S, C, H, O, L\}$.

4. **Assertion (A): The set $\{1, 8, 27, ..., 1000\}$ in the set-builder form is $\{x$: $x = n^3$, where $n \in N$ and $1 < n \leq 10\}$.**

Reason (R): In roster form, the order in which the elements are listed is immaterial.

Sol: We can see that each member in the given set is the cube of a natural number.
Hence, the given set in the set-builder form is $\{x : x = n^3$, where $n e\ N$ and $1 \leq n \leq 10\}$. Also, in roster form, the order in which the elements are listed is immaterial.

Answer Key

1. (c) 2. (a) 3. (d) 4. (b)

Subjective Questions

Very Short Answer Type Questions (1 or 2 M)

1. Write the solution set of the equation $x^2 + x - 2 = 0$ in roster form.

Sol. The given equation can be written as $(x - 1)(x + 2) = 0$, i.e., $x = 1, -2$ Therefore, the solution set of the given equation can be written in roster form as $\{1, -2\}$.

2. Write the set $A = \left\{x : x \in Z, x^2 < 20\right\}$ in the roster form.

Sol. It can be seen that the square of integers $0, \pm1, \pm2, \pm3, \pm4$ are less than 20.

$A = \{-4, -3, -2, -1, 0, 1, 2, 3, 4\}$

3. Write $\{x$: x is an integer and $-3 \le x < 7\}$ in roster form.

Sol. $\{-3, -2, -1, 0, 1, 2, 3, 4, 5, 6\}$

4. Write set $A = \{3, 6, 9, 12, 15\}$ in set-builder form.

Sol. $A = \{x$: x is a natural number multiple of 3 and $x < 18\}$

5. Write set $A = \{1, 4, 9, \ldots, 100\}$ in set-builder form.

Sol. $A = \left\{x : x = n^2, n \in N \text{ and } n < 11\right\}$

6. Which of the following sets are empty sets?

(i) $A = \{x : 4 < x < 5, x \in N\}$

(ii) $D = \{x : x^2 = 25$ **and** x **is an odd integer**$\}$

(iii) $\{x : x \in N$ **and** $x^2 = 9\}$

(iv) $\{x : x^2 - 3 = 0, x$ **is rational**$\}$

(v) A **= Set of odd natural numbers divisible by 2.**

(vi) B **= Set of odd prime numbers.**

Sol. (i) There is no element in this set, so A is empty set.

(ii) $D = \{-5, 5\}$, not empty set

(iii) $\{x : x \in N \text{ and } x^2 = 9\} = \{3\}$, so it is non-empty set.

(iv) Empty set

(v) As no odd natural number is divisible by 2, so set A is empty.

(vi) Since, 2 is only an even prime number.

$\therefore B = \{2\}$

So, B is not an empty set.

7. State which of the following sets are finite and which are infinite?

(i) $A = \left\{x : x \in Z \text{ and } x^2 - 2x - 3 = 0\right\}$

(ii) B **= Set of lines passing through a point.**

Sol: (i) $A = \left\{x : x \in Z \text{ and } x^2 - 2x - 3 = 0\right\} = \{3, -1\}$

Here, A has two elements. So, it is a finite set.

(ii) Since, infinite number of lines can pass through a point. So C is an infinite set.

Short Answer Type Questions (2 or 3 M)

1. Let $X = \{1, 2, 3, 4, 5, 6\}$. If n represent any member of X, express the following as sets:

(i) $n + 5 = 8$

(ii) n **is greater than 4**

Sol. (i) Let $B = \{x \mid x \in X \text{ and } x + 5 = 8\}$

Here, $B = \{3\}$ as $x = 3 \in X$ and $3 + 5 = 8$ and there is no other element belonging to X such that $x + 5 = 8$.

(ii) Let $C = \{x \mid x \in X, x > 4\}$

Therefore, $C = \{5, 6\}$

2. Write the following sets in the roster form.

(i) $A = \{x \mid x$ **is a positive integer less than 10 and** $2x - 1$ **is an odd number**$\}$

(ii) $C = \{x : x^2 + 7x - 8 = 0, x \in R\}$

Sol. (i) $2x - 1$ is always an odd number for all positive integral values of x since $2x$ is an even number.

In particular, $2x - 1$ is an odd number for $x = 1, 2, \ldots, 9$.

Therefore, $A = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$

(ii) $x^2 + 7x - 8 = 0$

$(x + 8)(x - 1) = 0$

$x = -8$ or $x = 1$

Therefore, $C = \{-8, 1\}$

3. Describe the following sets in roster form.

(i) The set of all letters in the word 'ALGEBRA'.

(ii) The set of all natural numbers less than 7.

(iii) The set of squares of integers.

(iv) The set of all letters in the word "TRIGONOMETRY".

Sol: (i) $\{A, L, G, E, B, R\}$

(ii) $\{1, 2, 3, 4, 5, 6\}$

(iii) $\{0, 1, 4, 9, 16, \ldots\}$

(iv) $\{T, R, I, G, O, N, M, E, Y\}$

4. Which of the following sets are singleton/nonsingleton?

(i) $A = \{x : |x| = 7, x \in N\}$

(ii) $B = \left\{x : x^2 + 2x + 1 = 0, x \in N\right\}$

(iii) $C = \left\{x : x^2 = 9, |x| \le 3, x \in N\right\}$

Sol: (i) We have, $A = \{x : |x| = 7, x \in N\} = \{7\}$,

$[\because |x| = 7 \Rightarrow x = \pm 7, \text{ but } x \in N]$

This set is a singleton set.

(ii) We have, $B = \left\{x : x^2 + 2x + 1 = 0, x \in N\right\}$

Now, $x^2 + 2x + 1 = 0$

$\Rightarrow (x + 1)^2 = 0 \Rightarrow x = -1$

2 OPERATIONS ON SETS

Important Terms

1. **Equivalent Sets:** Two sets are equivalent if they have the same number of elements.

   Equal Sets: Two sets are considered equal if and only if they contain exactly the same elements.

2. **Subset:** A set whose elements are all members of another set. If set A is a subset of B, it is denoted as $A \subseteq B$.

3. **Proper Subset (or Strict Subset):** A subset of a set that is not equal to the set itself, denoted as $A \subset B$.

4. **Universal Set (U):** A set that contains all objects under consideration for a particular problem.

5. **Power Set:** The set of all subsets of a given set, including the empty set and the set itself.

6. **Intervals:** In the context of real numbers, intervals are sets of numbers that include all numbers between two endpoints.

7. **Complement of a Set:** The set of elements in the universal set that are not in a given set.

7. **Union:** The set containing all elements that are in either of the sets being combined.

9. **Intersection:** The set containing elements common to all sets being intersected.

10. **Disjoint Set:** Two sets that have no elements in common.

    Difference of Sets: The difference of two sets, denoted as A−B, is a fundamental operation in set theory that results in a new set containing elements that are in the first set (A) but not in the second set (B).

    Venn Diagram: A Venn diagram is a visual representation used in logic and set theory to show the relationships between different sets.

Important Symbols

1. $\cup$ (Union)
2. $\cap$ (Intersection
3. A' (Complement)
4. $\subset$ (Subset)
5. $\not\subseteq$ (not a subset of)
6. ϕ (Empty Set)
7. $P(A)$ (Power Set)
8. $A=B$ (Equality of Sets)
9. $A-B$ (Difference of Sets)

Important Concepts

Set : a set is a well-defined collection of objects

If a is an element of a set A, we say that "a belongs to A" the Greek symbol $\in$ (epsilon) is used to denote the phrase 'belongs to'. Thus, we write $a \in A$. If 'b' is not an element of a set A, we write $b \notin A$ and read "b does not belong to A".

There are two methods of representing a set:

(i) Roster or tabular form

(ii) Set-builder form.

In roster form, all the elements of a set are listed, the elements are being separated by commas and are enclosed within brackets { }. For example, the set of all even positive integers less than 7 is described in roster form as {2, 4, 6}.

In set-builder form, all the elements of a set possess a single common property which is not possessed by any element outside the set. For example, in the set $\{a, e, i, o, u\}$, all the elements possess a common property, namely, each of them is a vowel in the English alphabet, and no other letter possess this property. Denoting this set by V, we write $V = \{x : x$ is a vowel in English alphabet$\}$

- **Empty Set:** A set which does not contain any element is called the empty set or the null set or the void set. The empty set is denoted by the symbol ϕ or { }.
- **Finite and Infinite Sets:** A set which is empty or consists of a definite number of elements is called finite otherwise, the set is called infinite.
- **Equal Sets:** Two sets A and B are said to be equal if they have exactly the same elements and we write $A = B$. Otherwise, the sets are said to be unequal and we write $A \neq B$.
- **Subsets:** A set A is said to be a subset of a set B if every element of A is also an element of B.

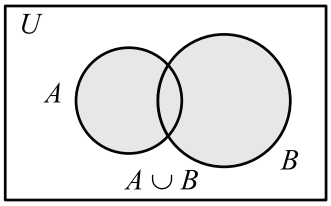
  In other words, $A \subset B$ if whenever $a \in A$, then $a \in B$. Thus $A \subset B$ if $a \in A \Rightarrow a \in B$

  If A is not a subset of B, we write $A \subseteq B$.

  - Every set A is a subset of itself, i.e., $A \subset A$.
  - ϕ is a subset of every set.
  - If $A \subset B$ and $A \neq B$, then A is called a proper subset of B and B is called superset of A.
  - If a set A has only one element, we call it a singleton set. Thus, $\{a\}$ is a singleton set.
  - Closed Interval: $[a, b] = \{x : a \leq x \leq b\}$ where a, b (Set of Real Numbers)
  - Open Interval: $(a, b) = \{x : a < x < b\}$
  - Semi Closed/Semi open Interval: $[a, b) = \{x : a \leq x < b\}$
  - Semi Open/Semi closed Interval: $(a, b] = \{x : a < x \leq b\}$

- **Power Set:** The collection of all subsets of a set A is called the power set of A. It is denoted by $P(A)$

  If A is a set with $n(A) = m$, then it can be shown that $n[P(A)] = 2^m$.
- **Universal Set:** The largest set under consideration is called Universal set.
- **Union of sets:** The union of two sets A and B is the set C which consists of all those elements which are either in A or in B (including those which are in both). In symbols, we write.

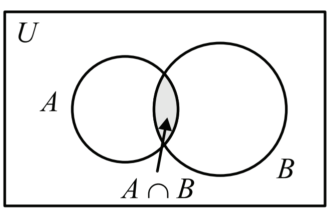


$A \cup B = \{x : x \in A \text{ or } x \in B\}$.

$X \in A \cup B \Rightarrow x \in A \text{ or } x \in B$

$x \notin A \cup B \Rightarrow x \notin A \text{ and } x \notin B$

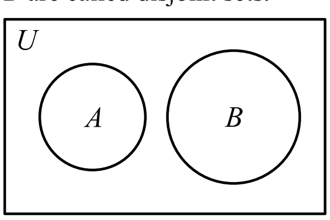
- Some Properties of the Operation of Union
  (i) $A \cup B = B \cup A$ (Commutative law)
  (ii) $(A \cup B) \cup C = A \cup (B \cup C)$ (Associative law)
  (iii) $A \cup \phi = A$ (Law of identity element, ϕ is the identity of $\cup$)
  (iv) $A \cup A = A$ (Idempotent law)
  (v) $U \cup A = U$ (Law of U)
- **Intersection of sets:** The intersection of two sets A and B is the set of all those elements which belong to both A and B. Symbolically, we write $A \cap B = \{x : x \in A \text{ and } x \in B\}$



$x \in A \cap B \Rightarrow x \in A \text{ and } x \in B$

$x \notin A \cap B \Rightarrow x \notin A \text{ or } x \notin B$

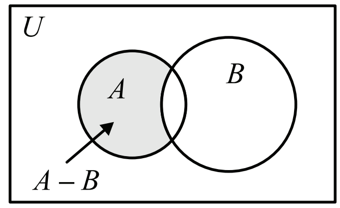
- **Disjoint sets:** If A and B are two sets such that $A \cap B = \phi$, then A and B are called disjoint sets.



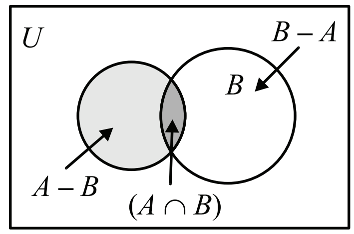
- **Some Properties of Operation of Intersection**
  (i) $A \cap B = B \cap A$ (Commutative law).
  (ii) $(A \cap B) \cap C = A \cap (B \cap C)$ (Associative law).
  (iii) $\phi \cap A = \phi$, $U \cap A = A$ (Law of ϕ and U).
  (iv) $A \cap A = A$ (Idempotent law)
  (v) $A \cap (B \cup C) = (A \cap B) (A \cap C)$ (Distributive law) i.e., $\cap$ distributes over $\cup$
- **Difference of sets:** The difference of the sets A and B in this order is the set of elements which belong to A but not to B.

  Symbolically, we write $A - B$ and read as "A minus B".

  $A - B = \{x : x \in A \text{ and } x \notin B\}$.



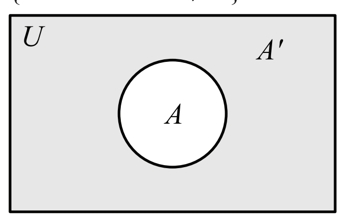
- The sets $A - B$, $A \cap B$ and $B - A$ are mutually disjoint sets, i.e., the intersection of any of these two sets is the null set.



- **Complement of a Set:** Let U be the universal set and A a subset of U.

  Then the complement of A is the set of all elements of U which are not the elements of A. Symbolically, we write A' to denote the complement of A with respect to U.

  Thus, $A' = \{x : x \in U \text{ and } x \notin A\}$. Obviously $A' = U - A$



- **Some Properties of Complement Sets**
  1. Complement laws: (i) $A \cup A' = U$ (ii) $A \cap A' = \phi$
  2. De Morgan's law: (i) $(A \cup B)' = A' \cap B'$ (ii) $(A \cap B)' = A' \cup B'$
  3. Law of double complementation: $(A')' = A$
  4. Laws of empty set and universal set $\phi' = U$ and $U' = \phi$.

Real Life Applications

1. **Project Management:** Projects can be broken down into sets of tasks, with dependencies between tasks defined by set operations.
2. **Social Sciences:** Researchers use sets to define groups, categories, and subsets within a population for surveys and studies.
3. **Accounting:** Accountants use sets to track different accounts, transactions, and to ensure all financial records are accurate and up-to-date.
4. **Sports Statistics:** In sports analytics, sets are used to track player statistics, team performance, and opposition strategies.

Sol. (i) Given, $X = \{a, b, c, d, e, f\}$

and $Y = \{f, b, d, g, h, k\}$

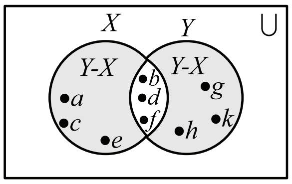
$\therefore$ $X\text{-}Y = \{a, b, c, d, e, f\} - \{f, b, d, g, h, k\} = \{a, c, e\}$

[only those elements of X which do not belong to Y]

and $Y\text{-}X = \{f, b, d, g, h, k\} - \{a, b, c, d, e, f\}$

$= \{g, h, k\}$

[only those elements of Y which do not belong to X]



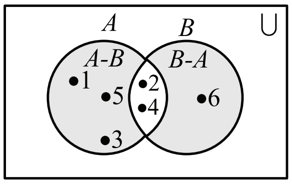
(ii) Given, $A = \{1,2,3,4,5\}$ and $B = \{2,4,6\}$

$\therefore \quad A - B = \{1,2,3,4,5\} - \{2,4,6\}$

$\Rightarrow \quad A - B = \{1,3,5\}$

[only those elements of A which do not belong to B] and $B–A = \{2,4,6\} - \{1,2,3,4,5\} = \{6\}$

[only those elements of B which do not belongs to A]



Ex. Let $U=\{1,2,3,4,5,6,7,8,9\}$, $A = \{1,2,3,4\}$, $B = \{2,4,6,8\}$ and $C = \{3,4,5,6\}$. Find

(i) A' (ii) B'

(iii) $(A \cap C)'$ (iv) $(A \cup B)'$

(v) $(A')'$ (vi) $(B - C)'$

Sol. Given, $U = \{1,2,3,4,5,6,7,8,9\}$, $A = \{1,2,3,4\}$

$B = \{2,4,6,8\}$ and $C = \{3,4,5,6\}$

(i) $A' = U - A = \{1,2,3,4,5,6,7,8,9\} - \{1,2,3,4\}$
$= \{5,6,7,8,9\}$

(ii) $B' = U - B = \{1,2,3,4,5,6,7,8,9\} - \{2,4,6,8\} = \{1,3,5,7,9\}$

(iii) $A \cap C = \{3,4\}$

$\therefore (A \cap C)' = U - (A \cap C) = \{1,2,3,4,5,6,7,8,9\} - \{3,4\}$
$= \{1,2,5,6,7,8,9\}$

(iv) $A \cup B = \{1,2,3,4,6,8\}, (A \cup B)' = U - (A \cup B)$
$= \{1,2,3,4,5,6,7,8,9\} - \{1,2,3,4,6,8\} = \{5,7,9\}$

(v) $(A')' = U - A' = \{1,2,3,4,5,6,7,8,9\} - \{5,6,7,8,9\}$
$= \{1,2,3,4\}$ [Using part (i)]

Alternatively

We know that, $(A')' = A$

$\therefore (A')' = \{1,2,3,4\}$

(vi) Now, $B - C = \{2, 8\}$

$(B - C)' = U - (B - C)$

$= \{1,2,3,4,5,6,7,8,9\} - \{2,8\}$

$= \{1,3,4,5,6,7,9\}$

COMPETENCY BASED SOLVED EXAMPLES

Multiple Choice Questions (1 M)

1. The number of elements in the Power set $P(S)$ of the set $S = \{1, 2, 3\}$ is:

(*a*) 4 (*b*) 8

(*c*) 2 (*d*) None of these

Sol: Number of elements in the set $S = 3$

Number of elements in the power set of set $S = \{1, 2, 3\}$ $= 2^3 = 8$

2. Cardinality of the power set $P(A)$ of a set A having 'n' number of elements is equal to:

(*a*) n (*b*) $2n$

(*c*) 2^n (*d*) n^2

Sol: The cardinality of the power set is equal to 2^n, where n is the number of elements in a given set.

3. If the sets A and B are as follows : $A = \{1,2,3,4\}$, $B = \{3,4,5,6\}$, then

(*a*) $A - B = \{1,2\}$

(*b*) $B - A = \{5\}$

(*c*) $[(A - B) - (B - A)] \cap A = \{1,2\}$

(*d*) $[(A - B) - (B - A)] \cup A = \{3,4\}$

Sol: Given $A = \{1,2,3,4\}$, $B = \{3,4,5,6\}$,

$\therefore A - B = \{1,2\}$

4. Given the sets $A = \{1, 3, 5\}$, $B = \{2,4,6\}$ and $C = \{0,2,4,6,8\}$. Which of the following may be considered as universal set for all the three sets A, B and C?

(*a*) $\{0,1,2,3,4,5,6\}$

(*b*) ϕ

(*c*) $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$

(*d*) $\{1, 2, 3, 4, 5, 6, 7, 8\}$

Sol: Universal set $= \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$

5. Let $V = \{a,e,i,o,u\}$ and $B = \{a, i, k, u\}$. Value of $V - B$ and $B - V$ are respectively

(*a*) $\{e, o\}$ and $\{k\}$ (*b*) $\{e\}$ and $\{k\}$

(*c*) $\{0\}$ and $\{k\}$ (*d*) $\{e, o\}$ and $\{k, i\}$

Sol: We have, $V = \{a,e,i,o,u\}$ and $B = \{a,i,k,u\}$

$\therefore V - B = \{e,o\}$

$\because$ The element e, o belong to V but not to B

$\therefore B - V = \{k\}$

$\because$ The element k belong to $B - V$ but not to $V - B$.

Nailing the Right Answer

Students, A-B is not same as B-A generally for two sets A and B.

6. Let $A=\{a,b\}, B=\{a,b,c\}$. What is $A \cup B$?

(a) $\{a,b\}$ (b) $\{a,c\}$

(c) $\{a,b,c\}$ (d) $\{b,c\}$

Sol: $A \cup B = \{a,b\} \cup \{a,b,c\} = \{a,b,c\}$

7. Let $A = \{1,2,3,4,5,6,7,8,9,10\}$ and $B = \{2,3,5,7\}$. Then, which of following is true?

(a) $A \cap B = A$ (b) $A \cap B = B$

(c) $A \cap B \not\subset B$ (d) None of these

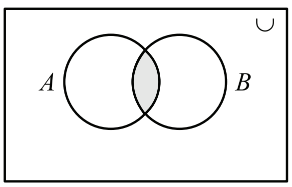
Sol: Given $A = \{1,2,3,4,5,6,7,8,9,10\}$

and $B = \{2,3,5,7\}$

$\therefore A \cap B = \{2,3,5,7\}$

$A \cap B = B$

8. The shaded portion represented in the Venn diagram is



(a) $A \cup B$ (b) $A \cap B$

(c) $A - B$ (d) $B - A$

Sol: The intersection of two sets A and B is set of all those elements which belong to both A and B i.e., $A \cap B$.

The shaded portion in the given figure indicates the intersection of A and B i.e., $A \cap B$.

Answer Key

1. (b) 2. (c) 3. (a) 4. (c) 5. (a) 6. (c) 7. (b) 8. (b)

Assertion and Reason (1 M)

Direction: In each of the following questions, a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as

(a) Both assertion and reason are true, and reason is the correct explanation of assertion.

(b) Both assertion and reason are true, but reason is not the correct explanation of assertion.

(c) Assertion is true, but reason is false.

(d) Assertion is false, but reason is true

1. Assertion: The union of two finite sets is always finite.

Reason: The union of two finite sets contains all the elements from both sets, which is a finite collection.

Sol. Both assertion and reason are true and reason is the correct explanation of assertion

2. Assertion: The intersection of two finite sets is always finite.

Reason: The intersection of two finite sets contains only the common elements, which is also a finite collection.

Sol. Both assertion and reason are true and reason is the correct explanation of assertion

3. Assertion: The power set of a set with 'n' elements contains (2^n) subsets.

Reason: Each element in the power set can either be included or excluded from the original set, resulting in (2^n) possible subsets.

Sol. Both assertion and reason are true, and reason is the correct explanation of assertion

4. Assertion (A): Let $A = \{2,3,4\}$ and $B = \{1,2,3,4\}$ Then $A \subset B$

Reason (R): If every element of set A is also an element of set B, then A is a subset of B.

Sol. Both (A) and (R) are true and (R) is the correct explanation of (A).

Explanation: Since, every element of A is in B so $A \subset B$.

Answer Key

1. (a) 2. (a) 3. (a) 4. (a)

Subjective Questions

Very Short Answer Type Questions (1 or 2 M)

1. Let $U = \{1, 2, 3, 4, 5, 6\}$, $A = \{2, 3\}$ and $B = \{3, 4, 5\}$. Find A', B', $A' \cap B'$, $A \cup B$ and hence show that $(A \cup B)' = A' \cap B'$.

Sol. Given,

$U = \{1, 2, 3, 4, 5, 6\}$, $A = \{2, 3\}$ and $B = \{3, 4, 5\}$

$A' = \{1, 4, 5, 6\}$

$B' = \{1, 2, 6\}$.

Hence, $A' \cap B' = \{1, 6\}$

Also, $A \cup B = \{2, 3, 4, 5\}$

$(A \cup B)' = \{1, 6\}$

Therefore, $(A \cup B)' = \{1, 6\} = A' \cap B'$

2. Let $A = \{2,4,6,8\}$ and $B = \{6,8,10,12\}$. Find $A \cup B$.

Sol. If $A = \{2,4,6,8\}$ and $B = \{6,8,10,12\}$, then

$A \cup B = \{2,4,6,8,10,12\}$

3. **Find the smallest set A such that $A \cup \{1, 2\} = \{1, 2, 3, 5, 9\}$.**

Sol. $A = \{3, 5, 9\}$

4. **Let $U = \{1,2,3,4,5,6,7,8,9,10\}$, $A = \{1,2,3\}$, $B = \{2,4,6,7\}$ and $C = \{2,3,4,8\}$, then find $(B \cup C)'$, $(A \cup B)'$.**

Sol. $(B \cup C)' = \{1,5,9,10\}$ and $(A \cup B)' = \{5, 8, 9, 10\}$

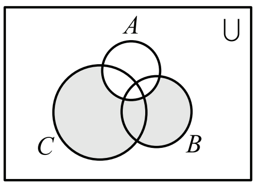
5. **If $A = \{x$: x is a positive multiple of 3$\}$and $U = \{x$: x is a natural number$\}$, then find A'.**

Sol. $\{x$: $x \in N$ and x is not a multiple of 3$\}$

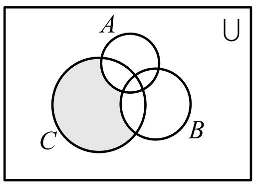
6. **Represent the following sets in Venn diagram.**

(i) $A' \cap (B \cup C)$ (ii) $A' \cap (C - B)$

Sol.



(i)



(ii)

Short Answer Type Questions (2 or 3 M)

1. **Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$, $A = \{2, 4, 6, 8\}$ and $B = \{2, 3, 5, 7\}$. Verify that,**

(i) $(A \cup B)' = A' \cap B'$

(ii) $(A \cap B)' = A' \cup B'$.

Sol. $(A \cup B)' = \{1,9\}$, $A' \cap B' = \{1,3,5,7,9,\} \cap \{1, 4, 6, 8, 9\} = \{1, 9\}$

2. **Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$**
$A = \{1, 2, 3, 4\}$, $B = \{2, 4, 6, 8\}$, $C = \{3, 4, 5, 6\}$.
Find (i) $(A \cap C)'$ (ii) $(A')'$ (iii) $(B - C)'$

Sol. (i) $(A \cap C)' = \{1, 2, 5, 6, 7, 8, 9\}$

(ii) $(A')' = \{1, 2, 3, 4\}$

(iii) $(B - C)' = \{1, 3, 4, 5, 6, 7, 9\}$

3. **Write down the subsets of the following sets.**

(i) $\{1,2,3\}$

(ii) $\{\phi\}$

Sol. (i) $\phi, \{1\}, \{2\}, \{3\}, \{1,2\}, \{2,3\}, \{1,3\}, \{1,2,3\}$

(ii) Clearly, $\{\phi\}$ is the power set of empty set ϕ. So, the subsets are ϕ and $\{\phi\}$.

> **Nailing the Right Answer**
>
> Students ϕ is subset of empty set and empty set is a subset of itself.

4. **Write the following as intervals and also represent on real line.**

(i) $\{x : x \in R, -3 < x \le 7\}$

(ii) $\{x : x \in R, -11 < x < -7\}$

(iii) $\{x : x \in R, 0 \le x < 11\}$

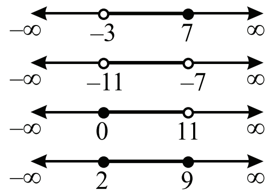
(iv) $\{x : x \in R, 2 \le x \le 9\}$

Sol. (i) $(-3, 7]$

(ii) $(-11, -7)$

(iii) $[0, 11)$

(iv) $[2, 9]$



5. **State whether each of the following statement is true or false.**

(i) $A = \{2,4,6,8\}$ and $B = \{1,3,5\}$ are disjoint sets.

(ii) $A = \{a, e, i, o, u\}$ and $B = \{a, b, c, d\}$ are disjoint sets.

Sol. (i) We have, $A = \{2, 4, 6, 8\}$ and $B = \{1, 3, 5\}$

Now, $A \cap B = \{2, 4, 6, 8\} \cap \{1, 3, 5\}$

$\Rightarrow A \cap B = \phi$

Therefore, A and B are disjoint sets.

So, the statement is true.

(ii) We have, $A = \{a, e, i, o, u\}$ and $B = \{a, b, c, d\}$

Now, $A \cap B = \{a\}$

i.e. $A \cap B \ne \phi$

Therefore, A and B are not disjoint sets.

So, the statement is false.

6. **Let A and B be two sets. Using properties of set, prove that**

(i) $A \cap B' = \phi \Rightarrow A \subseteq B$

(ii) $A' \cup B = U \Rightarrow A \subseteq B$

Sol. (i) We have, $A = (A \cap U) = A \cap (B \cup B')$

$= (A \cap B) \cup (A \cap B')$

$= (A \cap B) \cup \phi$

$\Rightarrow A = A \cap B \Rightarrow A \subseteq B$

(ii) We have $A' \cup B = U$

$\Rightarrow (A' \cup B)' = U'$

$\Rightarrow (A')' \cap B' = \phi$

$\Rightarrow A \cap B' = \phi$

Now, from part (i), we get $A \subseteq B$

Long Answer Type Questions (4 or 5 M)

1. **If $A = [-3, 5)$, $B = (0, 6]$ then find (i) A – B, (ii) $A \cup B$**

Sol. (i) $[-3, 0]$; (ii) $[-3, 6]$

2. **Let $U = \{1,2,3,4,5,6\}$ $A = \{2,3\}$ and $B = \{3,4,5\}$**

Find $A' \cap B', A \cup B$ and hence show that

$(A \cup B)' = A' \cap B'$.

Sol: $A' = U - A = \{1,4,5,6\}$

$B' = U - B = \{1,2,6\}$

$A \cup B = \{2,3,4,5\}$

$(A \cup B)' = U - (A \cup B) = \{1,6\}$

$A' \cap B' = \{1,6\}$

Hence proved.

3. **For any two sets A and B prove by using properties of sets that:**

$(A \cap B) \cup (A - B) = A$

Sol. L.H.S. $= (A \cap B) \cup (A - B)$

$= (A \cap B) \cup (A \cap B') \{\because (A - B) = (A \cap B')\}$

$= A \cap (B \cup B')$ {Distributive Law}

$= A \cap (U) \{\because B \cup B' = U\}$

$= A$

4. **If A and B are two sets such that $A \cup B = A \cap B$, then prove that $A = B$**

Sol. Let $a \in A$, then $a \in A \cup B$

Since $A \cup B = A \cap B$

$a \in A \cap B$. So $a \in B$

Therefore $A \subset B$

Similarly if $b \in B$,

Then $b \in A \cup B$. Since

$A \cup B = A \cap B, b \in A \cap B$

So $b \in A$

Therefore, $B \subset A$

Thus $A = B$

MISCELLANEOUS EXERCISE

Multiple Choice Questions (1 M)

1. If $A = \{x, y\}$ then the power set of A is:

   (a) $\{x^x, y^y\}$

   (b) $\{\phi, x, y\}$

   (c) $\{\phi, \{x\}, \{2y\}\}$

   (d) $\{\phi, \{x\}, \{y\}, \{x, y\}\}$

2. Which of the following collections are sets?

   (a) The collection of all the days of a week

   (b) A collection of 11 best hockey player of India.

   (c) The collection of all rich person of Delhi

   (d) A collection of most dangerous animals of India.

3. Which of the following properties are associative law?

   (a) $A \cup B = B \cup A$

   (b) $A \cup C = C \cup A$

   (c) $A \cup D = D \cup A$

   (d) $(A \cup B) \cup C = A \cup (B \cup C)$

4. If ϕ denotes the empty set, then which one of the following is correct?

   (a) $\phi \in \phi$ (b) $\phi \in \{\phi\}$

   (c) $\{\phi\} \in \{\phi\}$ (d) $0 \in \phi$

5. Which one of the following is an infinite set?

   (a) The set of human beings on the earth

   (b) The set of water drops in a glass of water

   (c) The set of trees in a forest

   (d) The set of all primes

6. The set $A = \{x : x \in R, x^2 = 16$ and $2x = 6\}$ equals

   (a) ϕ (b) {14, 3, 4}

   (c) {3} (d) {4}

7. $A = \{x : x \neq x\}$ represents

   (a) {x} (b) {1}

   (c) {} (d) {0}

8. Which of the following is a null set?

   (a) {0}

   (b) $\{x : x > 0$ or $x < 0\}$

   (c) $\{x : x^2 = 4$ or $x = 3\}$

   (d) $\{x : x^2 + 1 = 0, x \in R\}$

Assertion and Reason (1 M)

Direction: In each of the following questions, a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as

(*a*) Both assertion and reason are true, and reason is the correct explanation of assertion.

(*b*) Both assertion and reason are true, but reason is not the correct explanation of assertion.

(*c*) Assertion is true, but reason is false.

(*d*) Assertion is false, but reason is true

1. **Assertion (A):** Set of English alphabets is the universal set for the set of vowels in English alphabets

   Reason (R): The set of vowels is the subset of consonants in the English alphabets

2. **Assertion (A):** Let $A = \{1, 2, 3\}$ and $B = \{1, 2, 3, 4\}$ then $A \subset B$

   Reason (R): A set A is said to be a subset of a set B if every element of A is also an element of B.

3. **Assertion (A):** 'The collection of all natural numbers less than 100' is a set.

   Reason (R): A set is a well-defined collection of distinct objects.

4. **Assertion (A):** The set E = the set of all letters in the word 'TRIGONOMETRY', in the roster form is $\{T, R, I, G, O, N, M, E, Y\}$.

   Reason (R): In roaster form distinct elements is written and separated by comma

5. **Assertion (A):** If A is a subset of B and B is a subset of A, then $A = B$.

   Reason (R): If every element of set A is in set B and vice versa, then the two sets are equal.

Subjective Questions

Very Short Answer Type Questions (1 or 2 M)

1. Write the set $\{x : x$ is a positive integer and $x^2 < 40\}$ in the roster form.
2. Write the set $A = \{1, 4, 9, 16, 25, \ldots\}$ in set-builder form.
3. Let $A = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$ and $B = \{2, 3, 5, 7\}$. Find $A \cap B$ and hence show that $A \cap B = B$.
4. Let $A = \{2, 4, 6, 8\}$ and $B = \{6, 8, 10, 12\}$. Find $A \cup B$.
5. Let $A = \{a, e, i, o, u\}$ and $B = \{a, i, u\}$. Show that $A \cup B = A$
6. Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$ and $A = \{1, 3, 5, 7, 9\}$. Find A'.

Short Answer Type Questions (2 or 3 M)

1. Write the set $A = \{x : x \in N, x^2 < 20\}$ in roster form.
2. Which of the following sets are empty sets?
   $A = \{x : x^2 - 3 = 0$ and x is rational$\}$
   $B = \{x \in R : 0 < x < 1\}$
3. Write down all possible subsets of each of the following sets:
   (i) $\{1, \{1\}\}$ (ii) $\{1, 2, 3\}$
4. Write the following as intervals:
   $\{x : x \in R, -12 < x < -10\}$
   $\{x : x \in R, 3 \le x \le 4\}$
5. What Universal Set would you propose for each of the following:
   (i) the set of isosceles triangles?
   (ii) the set of right-angle triangles.
6. Which of the following sets are finite and which are infinite:
   $A = \{x : x \in Z$ and $x^2 - 5x + 6 = 0\}$
   $B = \{x : x \in Z$ and is even $\}$
   $C = \{x : x \in Z$ and $x > -10\}$
7. Let A and B be two sets. Prove that $(A - B) \cup B = A$ if and only if $B \subset A$.
8. Which of the following pairs of sets are equal? Justify your answer
   (i) $A = \{x : x$ is a letter of the word "LOYAL"$\}$
   $B = \{x : x$ is a letter of the word "ALLOY"$\}$
   (ii) $A = \{x : x \in Z$ and $x \le 8\}$
   $B = \{x : x \in R$ and $-4x + 3 = 0\}$

Long Answer Type Questions (4 or 5 M)

1. Three friends were having get together. Suddenly they decided to play with their names using sets. Name of friends were AARTI, CHARVI and AYSHA. They asked each other the following questions.
   (i) How letters used for AARTI are written in roster form as a set?
   (*a*) $\{A, R, T, I\}$
   (*b*) $\{x : x$ is a letter of the word AARTI$\}$
   (*c*) $\{A, T, I\}$
   (*d*) none of these
   (ii) What is the difference of set of letters of CHARVI and AYSHA?
   (*a*) $\{C, R, V, I\}$ (*b*) $\{C, S, V, I\}$
   (*c*) $\{C, T, V, I\}$ (*d*) $\{C, V, I\}$
   (iii) Form a union of sets taking the letters of names of friends.
   (*a*) $\{A, R, T, I, C, H, Y, V, S\}$
   (*b*) $\{A, R, T, I, C, H, V\}$
   (*c*) $\{A, R, C, H, V, Y, S\}$
   (*d*) none of these
   (iv) Form a set of intersection of sets taking the letters of names of friends.
   (*a*) $\{A\}$ (*b*) $\{A, R, T, I, C, H, V\}$
   (*c*) $\{A, R, C, H, V, Y, S\}$ (*d*) none of these
2. For all sets A, B and C. Is $(A - B) \cap (C - B) = (A \cap C) - B$? Justify your answer.
3. A, B and C are subset of universal set U. If $A = \{2, 4, 6, 8, 12, 20\}$, $B = \{3, 6, 9, 12, 15\}$, $C = \{5, 10, 15, 20\}$ and U is the set of all whole numbers. Draw a Venn diagram showing the relation of U, A, B and C.

4. Consider the sets ϕ, $A = \{1, 3\}$, $B = \{1, 5, 9\}$, $C = \{1, 3, 5, 7, 9\}$. Insert the symbol $\subset$ or $\not\subset$ between each of the following pair of sets:
   (i) $\phi \ldots B$ (ii) $A \ldots B$
   (iii) $A \ldots C$ (iv) $B \ldots C$
5. Prove that if $A \cup B = C$ and $A \cap B = \phi$ then $A = C - B$
6. Let A, B and C be three sets $A \cup B = A \cup C$ and $A \cap B = A \cap C$ show that $B = C$
7. If $u = \{a, e, i, o, u\}$
   $A = \{a, e, i\}$ and $B = \{e, o, u\}$
   $C = \{a, i, u\}$
   Then verify that $A \cap (B - C) = (A \cap B) - (A \cap C)$

Case Based Questions

Case Based-I

1. In a school at Bhubaneswar, students of class XI were forming some sets. Two Students Ankita and Babita form two sets $A = \{1, 2, 3, 4, 5\}$ and $B = \{2, 4, 6\}$.

Based on the above information answer the following:
(i) Find $A \cup B$
(ii) Find $A \cap B$
(iii) Find $A - B$ and $B - A$. Are they equal?

2. A class teacher Mamta Sharma of class XI write three sets A, B and C are such that $A = \{1, 3, 5, 7, 9\}$, $B = \{2, 4, 6, 8\}$ and $C = \{2, 3, 5, 7, 11\}$.
Answer the following questions which are based on above sets.
(i) Find $A \cap B$.
   (a) $\{3, 5, 7\}$ (b) ϕ
   (c) $\{1, 5, 7\}$ (d) $\{2, 5, 7\}$
(ii) Find $A \cap C$
   (a) $\{3, 5, 7\}$ (b) ϕ
   (c) $\{1, 5, 7\}$ (d) $\{3, 4, 7\}$
(iii) Which of the following is correct for two sets A and B to be disjoint?
   (a) $A \cap B = \phi$ (b) $A \cap B \neq \phi$
   (c) $A \cup B = \phi$ (d) $A \cup B \neq \phi$
(iv) Which of the following is correct for two sets A and C to be intersecting?
   (a) $A \cap C = \phi$ (b) $A \cap C \neq \phi$
   (c) $A \cup C = \phi$ (d) $A \cup C \neq \phi$
(v) Write the $n[P(B)]$.
   (a) 8 (b) 4
   (c) 16 (d) 12

3. To check the understanding of sets, a Math teacher writes two sets A and B having finite numbers of elements. The sum of cardinal numbers of two finite sets A and B is 9 . The ratio of a cardinal number of the power set of A is to a cardinal number of the power set of B is 8:1.

(A) The cardinal number of set A is:
   (a) 2 (b) 3
   (c) 6 (d) 8
(B) The cardinal number of set B is:
   (a) 2 (b) 3
   (c) 6 (d) 8
(C) The maximum value of $n(A \cup B)$ is:
   (a) 3 (b) 6
   (c) 8 (d) 9
(D) The minimum value of $\boldsymbol{n}(A \cup B)$ is:
   (a) 3 (b) 6
   (c) 8 (d) 9
(E) If $B \subset A$, then $n(A \cap B)$ is:
   (a) 3 (b) 6
   (c) 8 (d) 6

4. In a library, 25 students are reading books on physics, chemistry, and mathematics. It was found that 15 students were reading mathematics, 12 reading physics and 11 reading chemistry, 5 students reading both mathematics and chemistry, 9 students reading both physics and mathematics, 4 students reading both physics and chemistry, and 3 students reading all three subjects.

(A) Find the number of students reading only Chemistry.
(B) Find the number of students reading only Mathematics.
(C) Find the number of students reading at least one of the subject and also find the number of students reading none of the subjects.

ANSWER KEYS

Multiple Choice Questions

1. (*d*) **2.** (*a*) **3.** (*d*) **4.** (*b*) **5.** (*d*) **6.** (*a*) **7.** (*c*) **8.** (*d*) **9.** (*d*) **10.** (*c*)
11. (*a*) **12.** (*b*) **13.** (*b*) **14.** (*d*) **15.** (*c*) **16.** (*a*)

Assertion and Reason

1. (*c*) **2.** (*a*) **3.** (*a*) **4.** (*a*) **5.** (*a*)

HINTS & EXPLANATIONS

Multiple Choice Questions

1. (*d*) Let $A=\{x,y\}$

Power set = Set of all possible subsets of A

$\therefore P(A)=\{\phi,\{x\},\{y\},\{x,y\}\}$

2. (*a*) The days of a week are well defined.
Hence, the collection of all the days of a week, is a set.

3. (*d*)

4. (*b*) Since, ϕ is an empty set, $\phi\in\{\phi\}$

5. (*d*) In the given sets, the set of all primes is an infinite set.

6. (*a*) We have $x^2=16\Rightarrow x=\pm4$
Also, $2x=6\Rightarrow x=3$
There is no value of x which satisfies both the above equations. Thus the set A contains no elements
$\therefore A=\phi$

7. (*c*) Clearly $A=\phi=\{\}$

8. (*d*) $x^2+1=0$ has no solution in R.

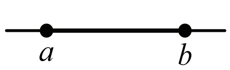
9. (*d*) It is clear from the figure that set $A\cup C$ is not shaded and set B is shaded other than $A\cup C$, i.e., $B-(A\cup C)$.

10. (*c*) We see that each member in the given set has the numerator one less than the denominator. Also, the numerator begins from 1 and do not exceed 6. Hence, in the set-builder form, the given set is

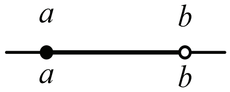
$$\left\{x:x=\frac{n}{n+1},\ \text{where } n\in N \text{ and } 1\le n\le 6\right\}$$

11. (*a*) Let $a,b\in R$ and $a<b$. Then, the set of real numbers $\{x:a<x<b\}$ is called an open interval. And a, b do not belong to this interval.

12. (*b*)

(*a*) 

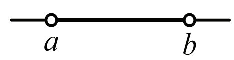
represents $[a, b]$.

(*b*) 

represents $[a, b)$.

(*c*) 

represents $(a, b]$

(*d*) 

represents (a, b).

13. (*b*) The interval in the figure is $[a, b]$.

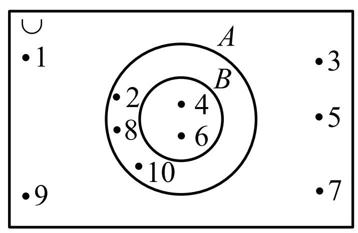
14. (*d*) $U=\{1,2,3,4,\ldots\ldots,10\}$

$A=\{2,4,6,8,10\}$, $B=\{4,6\}$

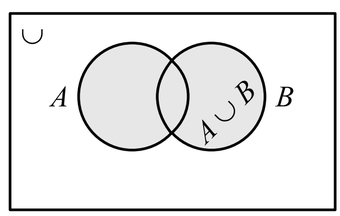
$\because$ All the elements of B are also in A.

$\therefore B\subset A$

$\Rightarrow$ Set B lies inside A in the Venn diagram.



15. (*c*) The union of two sets A and B can be represented by a Venn diagram as



16. (*a*) In the given figure, the shaded portion represents complement of set A.

Assertion and Reason

1. (*c*)

2. (*a*)

3. (*a*)

4. (*a*)

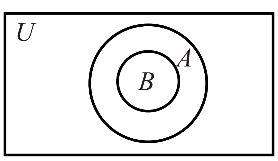
5. (*a*) Both assertion and reason are true and reason is the correct explanation of assertion

Subjective Questions

Very Short Answer Type Questions

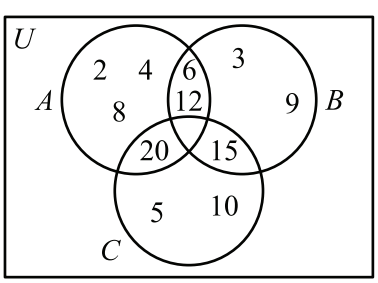
1. The required numbers are 1, 2, 3, 4, 5, 6. So, the given set in the roster form is {1, 2, 3, 4, 5, 6}
2. We may write the set A as $A = \{x : x$ is the square of a natural number$\}$ Alternatively, we can write $A = \{x : x = n^2$, where $n \in N\}$.
3. We have $A \cap B = \{2, 3, 5, 7\} = B$. We note that $B \subset A$ and that $A \cap B = B$
4. We have $A \cup B = \{2, 4, 6, 8, 10, 12\}$.
5. We have, $A \cup B = \{a, e, i, o, u\} = A$.
6. We note that 2, 4, 6, 8, 10 are the only elements of U which do not belong to A. Hence $A' = \{2, 4, 6, 8, 10\}$.

Short Answer Type Questions

1. $A = \{-4, -3, -2, 0, 1, 2, 3, 4\}$
2. A = Empty Set, B = Non – Empty Set
3. (i) ϕ, {1}, {{1}}, {1, {1}}
   (ii) ϕ, {1}, {2}, {3}, {1, 2}, {1, 3}, {2, 3}, {1, 2, 3}
4. (−12, −10) [3, 4]
5. The set of all triangles in plane.
   The set of all triangles in plane.
6. $A = \{2, 3\}$
   So, A is finite set.
   $B = \{\ldots, -6, -4, -2, 0, 2, 4, 6, \ldots\}$
   So, B is infinite set.
   $C = \{-9, -8, -7, \ldots\ldots\}$
   So C is infinite Set
7. 

8. (i) $A = B$ (ii) $A \neq B$

Long Answer Type Questions

1. (i) (*a*) (ii) (*a*)
   (iii) (*a*) (iv) (*a*)
2. By Verification
3. 

4. (i) $\phi \subset B$ as ϕ is a subset of every set.
   (ii) $A \not\subset B$ as $3 \in A$ and $3 \notin B$
   (iii) $A \subset C$ as $1, 3 \in A$ also belongs to C
   (iv) $B \subset C$ as each element of B is also an element of C.
5. $C - B = A$
   $= (A \cup B) - B$
   $= (A \cup B) \cap B'$
   $= B' \cap (A \cup B)$
   $= (B' \cap A) \cup (B' \cap B)$
   $= (B' \cap A) \cup \phi$
   $= B' \cap A$
   $= A \cap B'$
   $= A - B$
   $= A$ (Proved) $[\because A \cap B = \phi]$
6. Let $b \in B \Rightarrow b \in A \cup B$
   $\Rightarrow b \in A \cup C \ [\because A \cup B = A \cup C]$
   $\Rightarrow b \in A$ or $b \in C$
   if $b \in C$ then $B \subset C$
   if $b \in A$, then $b \in A \cap B \ [\because A \cap B = A \cap C]$
   $\Rightarrow b \in A \cap C$
   $\Rightarrow b \in C \Rightarrow B \subset C$
   Thus, in both cases $B \subset C$
   Similarly, $C \subset B$
   Hence $B = C$
7. $B - C = \{e, o\}$
   $A \cap (B - C) = e$
   $A \cap B = \{e\}$
   $A \cap C = \{a, i\}$
   $(A \cap B) - (A \cap C) = e$
   Hence proved.

Case Based Questions

1. (i) {1, 2, 3, 4, 5, 6}
   (ii) {2, 4}
   (iii) $A - B = \{1, 3, 5\}$, $B - A = \{6\}$….NO
2. (i) (*b*) (ii) (*a*)
   (iii) (*a*) (iv) (*b*)
   (v) (*c*)
3. (A) (*c*)
   Explanation: Let the cardinal numbers of sets A and B be $n(A)$ and $n(B)$ respectively.

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