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📚 SETS AND RELATIONS

Class 11 | CBSE Board 2025-26

Complete Study Material with Practice Questions

📞 +91 7869553517 | 🌐 www.mathlove.in

📍 Raipur, Chhattisgarh | Indore, Madhya Pradesh

📖 CHAPTER OVERVIEW

What You'll Learn: Sets and Relations form the foundation of modern mathematics. This chapter introduces fundamental concepts of set theory including types of sets, set operations, Venn diagrams, and the concept of relations. These concepts are extensively used in functions, probability, and higher mathematics.

Chapter Importance:

- Weightage in Board Exam: 8-10 marks (2-3 questions)
- Difficulty Level: Easy to Moderate
- Time Required: 8-10 hours of practice
- Prerequisites: Basic understanding of numbers and logic

PART A: SETS

◆ What is a Set?

A **set** is a well-defined collection of distinct objects. The objects in a set are called **elements** or **members** of the set.

Notation: Sets are usually denoted by capital letters A, B, C, etc., and elements by small letters a, b, c, etc.

Membership: If 'a' is an element of set A, we write **a** $\in$ **A** (a belongs to A). If 'a' is not an element of set A, we write **a** $\notin$ **A**.

1.1 Methods of Representing Sets

Method 1: Roster or Tabular Form

Elements are listed within braces { }, separated by commas.

Examples:

- A = {1, 2, 3, 4, 5} - Set of first five natural numbers
- B = {2, 4, 6, 8, 10} - Set of first five even natural numbers
- C = {a, e, i, o, u} - Set of vowels in English alphabet
- D = {January, February, March, ..., December} - Set of months

Method 2: Set-Builder Form

Elements are described by a property or rule.

Format: {x : property of x} or {x | property of x}

Examples:

- A = {x : x ∈ N, x ≤ 5} = {1, 2, 3, 4, 5}
- B = {x : x is an even natural number, x ≤ 10}
- C = {x : x is a vowel in English alphabet}
- D = {x : x^2 = 4} = {-2, 2}
- E = {x : x is a prime number less than 10} = {2, 3, 5, 7}

1.2 Types of Sets

Type of Set	Definition	Example
Empty/Null Set (∅)	A set containing no elements	{x : x^2 = -4} = ∅ (no real solution)
Singleton Set	A set containing exactly one element	{x : x + 5 = 5} = {0}
Finite Set	A set with countable number of elements	A = {1, 2, 3, 4, 5}
Infinite Set	A set with uncountable elements	N = {1, 2, 3, 4, ...} (Natural numbers)
Universal Set (U)	Set containing all elements under consideration	If discussing natural numbers, U = N
Equal Sets	Sets with exactly same elements (A = B)	{1, 2, 3} = {3, 2, 1}
Equivalent Sets	Sets with same number of elements	{a, b, c} and {1, 2, 3}

CARDINALITY OF A SET

n(A) = Number of elements in set A

Examples:

- If A = {1, 2, 3, 4, 5}, then n(A) = 5
- If B = ∅ (empty set), then n(B) = 0
- If C = {x : x is a letter in word "MATHEMATICS"}, then C = {M, A, T, H, E, I, C, S}, n(C) = 8

1.3 Subsets

Subset (⊆)

Set A is a subset of set B if every element of A is also an element of B.

Notation: $A \subseteq B$ (A is a subset of B)

Note:

- Every set is a subset of itself: $A \subseteq A$
- Empty set is a subset of every set: $\emptyset \subseteq A$
- If $A \subseteq B$ and $B \subseteq A$, then $A = B$

Proper Subset (⊂)

Set A is a proper subset of B if $A \subseteq B$ and $A \neq B$ (B has at least one element not in A)

Notation: $A \subset B$

NUMBER OF SUBSETS

If a set has n elements, then:

- **Total number of subsets = 2^n**
- **Number of proper subsets = $2^n - 1$**

Example: If A = {1, 2, 3}, then n(A) = 3

- Total subsets = $2^3 = 8$
- Subsets are: ∅, {1}, {2}, {3}, {1,2}, {1,3}, {2,3}, {1,2,3}
- Proper subsets = 8 - 1 = 7 (excluding {1,2,3} itself)

1.4 Power Set

Power Set P(A)

The power set of A is the set of all subsets of A, including ∅ and A itself.

Notation: P(A) or 2^A

Property: If n(A) = n, then n(P(A)) = 2^n

Example of Power Set

If A = {1, 2}, then:

P(A) = {∅, {1}, {2}, {1, 2}}

> n(A) = 2, so n(P(A)) = 2^2 = 4

1.5 Set Operations

1. UNION OF SETS (A ∪ B)

A ∪ B = {x : x ∈ A or x ∈ B}

Properties:

- A ∪ B = B ∪ A (Commutative)
- (A ∪ B) ∪ C = A ∪ (B ∪ C) (Associative)
- A ∪ A = A (Idempotent)
- A ∪ Ø = A (Identity)
- A ∪ U = U (where U is universal set)

Example: If A = {1, 2, 3} and B = {3, 4, 5}, then A ∪ B = {1, 2, 3, 4, 5}

2. INTERSECTION OF SETS (A ∩ B)

A ∩ B = {x : x ∈ A and x ∈ B}

Properties:

- A ∩ B = B ∩ A (Commutative)
- (A ∩ B) ∩ C = A ∩ (B ∩ C) (Associative)
- A ∩ A = A (Idempotent)
- A ∩ Ø = Ø
- A ∩ U = A (where U is universal set)

Example: If A = {1, 2, 3} and B = {3, 4, 5}, then A ∩ B = {3}

Disjoint Sets

Two sets A and B are called **disjoint** if they have no common elements.

A ∩ B = ∅

Example: A = {1, 2, 3} and B = {4, 5, 6} are disjoint sets.

3. DIFFERENCE OF SETS (A - B)

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

Properties:

- A - B ≠ B - A (Not Commutative)
- A - ∅ = A
- ∅ - A = ∅
- A - A = ∅
- A - B = A ∩ B' (complement of B)

Example: If A = {1, 2, 3, 4} and B = {3, 4, 5, 6}, then:

- A - B = {1, 2}
- B - A = {5, 6}

4. COMPLEMENT OF A SET (A' or A^C)

$$A' = U - A = \{x : x \in U \text{ and } x \notin A\}$$

Properties:

- $(A')' = A$
- $\emptyset' = U$ and $U' = \emptyset$
- $A \cup A' = U$
- $A \cap A' = \emptyset$

Example: If $U = \{1, 2, 3, 4, 5\}$ and $A = \{1, 2, 3\}$, then $A' = \{4, 5\}$

1.6 Important Laws of Set Operations

De Morgan's Laws

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

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

These laws show the relationship between union, intersection, and complement.

Distributive Laws

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

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

1.7 Venn Diagrams

What are Venn Diagrams?

Venn diagrams are pictorial representations of sets using circles or closed curves. They help visualize relationships between sets.

Key Points:

- Universal set U is represented by a rectangle
- Sets are represented by circles or closed curves inside the rectangle
- Common elements are shown in overlapping regions
- Useful for solving problems involving two or three sets

FORMULAS FOR TWO SETS

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

For disjoint sets ($A \cap B = \emptyset$):

$$n(A \cup B) = n(A) + n(B)$$

Other useful formulas:

- $n(A - B) = n(A) - n(A \cap B)$
- $n(A') = n(U) - n(A)$
- $n(A \cup B)' = n(U) - n(A \cup B)$

FORMULAS FOR THREE SETS

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

For finding only A:

$$n(\text{Only } A) = n(A) - n(A \cap B) - n(A \cap C) + n(A \cap B \cap C)$$

For exactly two sets:

$$n(\text{exactly in two sets}) = n(A \cap B) + n(B \cap C) + n(C \cap A) - 3n(A \cap B \cap C)$$

PART B: RELATIONS

◆ What is a Relation?

A **relation R** from set A to set B is a subset of the Cartesian product A × B.

R ⊆ A × B

If (a, b) ∈ R, we say "a is related to b" and write it as **a R b**.

2.1 Cartesian Product of Sets

Cartesian Product (A × B)

The Cartesian product of two sets A and B is the set of all ordered pairs (a, b) where a ∈ A and b ∈ B.

$$A \times B = \{(a, b) : a \in A \text{ and } b \in B\}$$

Example of Cartesian Product

If A = {1, 2} and B = {a, b, c}, then:

$A \times B = \{(1, a), (1, b), (1, c), (2, a), (2, b), (2, c)\}$

$B \times A = \{(a, 1), (a, 2), (b, 1), (b, 2), (c, 1), (c, 2)\}$

Note: $A \times B \neq B \times A$ (unless $A = B$)

NUMBER OF ELEMENTS IN CARTESIAN PRODUCT

$$n(A \times B) = n(A) \times n(B)$$

Example:

If $n(A) = 3$ and $n(B) = 4$, then $n(A \times B) = 3 \times 4 = 12$

Properties of Cartesian Product

- $A \times \emptyset = \emptyset$
- $\emptyset \times B = \emptyset$
- $A \times B \neq B \times A$ (Not commutative)
- $A \times (B \cup C) = (A \times B) \cup (A \times C)$ (Distributive over union)
- $A \times (B \cap C) = (A \times B) \cap (A \times C)$ (Distributive over intersection)
- If $A \subseteq B$, then $A \times C \subseteq B \times C$

2.2 Domain, Co-domain, and Range

For Relation R from A to B:

- **Domain of R:** Set of all first elements of ordered pairs in R
  $\text{Domain}(R) = \{a : (a, b) \in R\}$
- **Co-domain of R:** Set B itself

- **Range of R:** Set of all second elements of ordered pairs in R
  Range(R) = {b : (a, b) ∈ R}

Note: Range ⊆ Co-domain

Example

Let A = {1, 2, 3} and B = {4, 5, 6, 7}

Let R = {(1, 4), (1, 5), (2, 5), (3, 6)}

Then:

- Domain(R) = {1, 2, 3}
- Co-domain(R) = {4, 5, 6, 7}
- Range(R) = {4, 5, 6}

2.3 Types of Relations

Type of Relation	Definition	Example
Empty Relation	R = ∅ (no element of A is related to any element of B)	A = {1, 2}, R = ∅
Universal Relation	R = A × B (every element of A is related to every element of B)	A = {1, 2}, B = {3, 4}, R = {(1,3), (1,4), (2,3), (2,4)}
Identity Relation	I_A = {(a, a) : a ∈ A}	A = {1, 2, 3}, I_A = {(1,1), (2,2), (3,3)}
Reflexive Relation	(a, a) ∈ R for all a ∈ A	A = {1, 2}, R = {(1,1), (2,2), (1,2)}

Symmetric Relation	If (a, b) ∈ R, then (b, a) ∈ R	R = {(1,2), (2,1), (2,3), (3,2)}
Transitive Relation	If (a, b) ∈ R and (b, c) ∈ R, then (a, c) ∈ R	R = {(1,2), (2,3), (1,3)}
Equivalence Relation	R is reflexive, symmetric, and transitive	Equality relation (=)

🎯 Key Points to Remember for Relations

- **Reflexive:** Every element must be related to itself
- **Symmetric:** If a is related to b, then b must be related to a
- **Transitive:** If a→b and b→c, then a→c must hold
- **Equivalence Relation:** Must satisfy all three: Reflexive + Symmetric + Transitive
- Number of relations from A to B = $2^{n(A)\times n(B)}$

Checking if Relation is Equivalence

Let A = {1, 2, 3} and R = {(1,1), (2,2), (3,3), (1,2), (2,1)}

Check Reflexive: (1,1), (2,2), (3,3) all present ✓

Check Symmetric: (1,2) present and (2,1) also present ✓

Check Transitive: (1,2) and (2,1) present, need (1,1) - present ✓

Conclusion: R is an equivalence relation.

2.4 Inverse of a Relation

Inverse Relation (R^{-1})

If R is a relation from A to B, then the inverse relation R^{-1} from B to A is defined as:

$$R^{-1} = \{(b, a) : (a, b) \in R\}$$

Properties:

- Domain(R^{-1}) = Range(R)
- Range(R^{-1}) = Domain(R)
- $(R^{-1})^{-1} = R$

PRACTICE QUESTIONS - SETS (100 Questions)

Section A: Basic Level - Sets Fundamentals (Q1-Q30)

BASIC CONCEPTS (Q1-Q15):

1. Which of the following is a set?
   (a) Collection of tall students (b) Collection of prime numbers less than 10
   (c) Collection of beautiful flowers (d) Collection of good teachers
2. If A = {1, 2, 3, 4, 5}, which is true?
   (a) $3 \notin A$ (b) $6 \in A$ (c) $3 \in A$ (d) $\{3\} \in A$
3. Write {x : x is a natural number less than 6} in roster form.
4. Write {2, 4, 6, 8, 10} in set-builder form.
5. Find n(A) if A = $\{x : x^2 = 16\}$

6. Which of the following is an empty set?

   (a) {0} (b) Ø (c) $\{x : x^2 = 4\}$ (d) {Ø}

7. If A = {1, 2} and B = {1, 2}, then A and B are:

   (a) Equal (b) Equivalent (c) Both (d) None

8. Write the set of vowels in word "MATHEMATICS".

9. If A = {a, b, c}, then n(A) = ?

10. State whether true or false: {1, 2, 3} = {3, 2, 1}

11. Write the set $\{x : x \in N, x^2 < 10\}$ in roster form.

12. If A = {x : x is a prime number less than 5}, write A in roster form.

13. Which is a singleton set? (a) {0} (b) {0, 1} (c) Ø (d) {Ø, {1}}

14. The set {x : x is an even prime number} is equal to?

15. If A = {1, 2, {3, 4}, 5}, then which statement is correct?

    (a) $\{3, 4\} \subset A$ (b) $\{3, 4\} \in A$ (c) $3 \in A$ (d) $\{1\} \in A$

SUBSETS AND POWER SETS (Q16-Q30):

16. If A = {1, 2}, how many subsets does A have?

17. Write all subsets of A = {a, b}.

18. If n(A) = 4, find the number of proper subsets of A.

19. State whether true or false: $\emptyset \subset \{1, 2, 3\}$

20. If A = {1, 2, 3}, is $\{1, 2\} \subset A$ or $\{1, 2\} \in A$?

21. Find the power set of A = {1, 2}.

22. If $A \subset B$ and $B \subset C$, then prove $A \subset C$.

23. How many elements are there in P(A) if n(A) = 3?

24. If A = {Ø}, find P(A).

25. State whether true or false: Every set is a subset of itself.

26. If $A = \{1, 2, 3\}$ and $B = \{1, 2, 3, 4\}$, then A __ B ($\subset$ or $\supset$)?

27. Find $n(P(\emptyset))$.

28. If $\{1, 2\} \subset A$ and $A \subset \{1, 2, 3, 4\}$, how many sets A are possible?

29. Is $\emptyset = \{\emptyset\}$? Justify.

30. If $n(P(A)) = 256$, find $n(A)$.

Section B: Average Level - Set Operations (Q31-Q60)

UNION AND INTERSECTION (Q31-Q45):

31. If $A = \{1, 2, 3\}$ and $B = \{3, 4, 5\}$, find $A \cup B$.

32. If $A = \{1, 2, 3\}$ and $B = \{3, 4, 5\}$, find $A \cap B$.

33. If $A = \{a, b, c\}$ and $B = \{d, e, f\}$, find $A \cap B$.

34. State whether A and B are disjoint: $A = \{1, 2\}$, $B = \{3, 4\}$.

35. If $n(A) = 20$, $n(B) = 30$, $n(A \cap B) = 10$, find $n(A \cup B)$.

36. Verify: $A \cup B = B \cup A$ for $A = \{1, 2\}$ and $B = \{2, 3\}$.

37. If $A = \{1, 2, 3, 4\}$ and $B = \{3, 4, 5, 6\}$, find $(A \cup B)$ and $(A \cap B)$.

38. If $A \subset B$, what is $A \cup B$?

39. If $A \subset B$, what is $A \cap B$?

40. Prove: $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$ for any sets A, B, C.

41. If $U = \{1, 2, 3, 4, 5\}$, $A = \{1, 2, 3\}$, find $A \cup U$.

42. If $A = \{x : x \text{ is a multiple of } 2\}$ and $B = \{x : x \text{ is a multiple of } 3\}$, describe $A \cap B$.

43. In a class of 50 students, 30 like Mathematics and 25 like Science. If 10 like both, how many like at least one subject?

44. If $n(A - B) = 15$, $n(A \cap B) = 10$, find $n(A)$.

45. Draw Venn diagram for $A \cup B$ when A and B are disjoint sets.

COMPLEMENT AND DIFFERENCE (Q46-Q60):

46. If $U = \{1, 2, 3, 4, 5, 6\}$ and $A = \{2, 4, 6\}$, find A'.

47. If $A = \{1, 2, 3, 4\}$ and $B = \{3, 4, 5, 6\}$, find $A - B$.

48. If $A = \{1, 2, 3, 4\}$ and $B = \{3, 4, 5, 6\}$, find $B - A$.

49. Is $A - B = B - A$? Justify with example.

50. Verify: $(A \cup B)' = A' \cap B'$ for $U = \{1, 2, 3, 4, 5\}$, $A = \{1, 2\}$, $B = \{2, 3\}$.

51. Verify: $(A \cap B)' = A' \cup B'$ for any sets A and B.

52. If $U = \{1, 2, 3, 4, 5, 6, 7, 8\}$, $A = \{1, 2, 3, 4\}$, find $n(A')$.

53. Prove: $A - B = A \cap B'$.

54. If $A \cap B = A$, what can you say about sets A and B?

55. If $A \cup B = B$, what can you say about sets A and B?

56. Show that $A \cup A' = U$ and $A \cap A' = \emptyset$.

57. If $A' = B'$, prove that $A = B$.

58. Find $(A - B) \cup (B - A)$ for $A = \{1, 2, 3\}$ and $B = \{2, 3, 4\}$.

59. Prove: $(A')' = A$.

60. If $A = B$, prove $A \cap B = A \cup B$.

Section C: Above Average - Advanced Problems (Q61-Q80)

61. In a survey of 100 students: 60 like Tea, 50 like Coffee, 30 like both. How many like neither?

62. In a class: 35 students play Cricket, 30 play Football, 10 play both. If total students = 50, find students who play neither.

63. If $n(U) = 100$, $n(A) = 60$, $n(B) = 50$, $n(A \cap B) = 20$, find $n(A \cup B)'$.

64. Prove: $A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$ using Venn diagram.

65. In a group of 50: 25 read English, 30 read Hindi, 20 read Mathematics, 10 read English and Hindi, 8 read Hindi and Mathematics, 5 read English and Mathematics, 3 read all three. Find those who read at least one subject.

66. If $A \times B = \{(1, a), (1, b), (2, a), (2, b)\}$, find sets A and B.

67. If $n(A) = 4$ and $n(B) = 3$, find $n(A \times B)$.

68. If $A \times B = B \times A$, what can you conclude?

69. Write all elements of $\{1, 2\} \times \{a, b, c\}$.

70. If $(x, 3) = (2, y)$, find x and y.

71. Prove that $n(A \times B) = n(B \times A)$.

72. If $A = \{1, 2\}$ and $B = \{2, 3\}$, are $(1, 2)$ and $(2, 1)$ same in $A \times B$ and $B \times A$?

73. Show that $A \times (B \cup C) = (A \times B) \cup (A \times C)$.

74. If $A \times B = \emptyset$, what can you say about A and B?

75. Find the number of subsets of $A \times B$ if $n(A) = 2$ and $n(B) = 3$.

76. In a survey: 70% like Product A, 60% like Product B, 50% like both. Find % who like neither.

77. Prove: If $A \subseteq B$, then $A \times C \subseteq B \times C$.

78. Draw Venn diagram for three sets A, B, C where all three intersect.

79. If $n(A) = 3$, $n(B) = 4$, $n(C) = 5$, find maximum value of $n(A \cup B \cup C)$.

80. Using Venn diagram, prove: $n(A \cup B \cup C) = n(A) + n(B) + n(C) - n(A \cap B) - n(B \cap C) - n(C \cap A) + n(A \cap B \cap C)$.

Section D: Sets - Word Problems (Q81-Q100)

81. In a school of 500 students, 300 play Cricket, 250 play Hockey. If 150 play both, how many play only Cricket?
82. In a class, all students speak English or Hindi. 60% speak English, 70% speak Hindi. What % speak both?
83. In a survey: 40 people like Tea, 35 like Coffee, 20 like Juice, 15 like Tea and Coffee, 12 like Coffee and Juice, 10 like Tea and Juice, 5 like all three. How many were surveyed?
84. In a library: 200 students. 120 read Fiction, 100 read Non-fiction, 50 read both. How many read neither?
85. Of 100 students: 55 study Mathematics, 45 study Physics, 25 study both. Find: (a) only Math (b) only Physics (c) at least one.
86. In a city: 70% read Newspaper A, 50% read Newspaper B, 30% read both. What % read at least one?
87. In an exam: 75% passed in English, 60% in Math, 50% in both. What % failed in both?
88. 200 people surveyed: 100 like Apples, 80 like Oranges, 60 like Bananas, 40 like Apples and Oranges, 30 like Oranges and Bananas, 35 like Apples and Bananas, 20 like all three. How many like exactly one fruit?
89. In a college: 120 students. 60 in Drama, 70 in Music, 80 in Dance, 20 in all three, 30 in Drama and Music, 35 in Music and Dance, 25 in Drama and Dance. How many are in at least one activity?

90. Out of 50 students: 30 like Ice cream, 25 like Chocolate, 20 like Cake, 12 like Ice cream and Chocolate, 10 like Chocolate and Cake, 8 like Ice cream and Cake, 5 like all three. How many like none?
91. In a group of tourists: everyone visited Paris or London or both. 35 visited Paris, 40 visited London. If total = 60, how many visited both cities?
92. In a class: 45 like Burger, 30 like Pizza, 15 like both. If class strength = 60, how many like neither?
93. 70 people were asked about three TV channels A, B, C. 40 watch A, 35 watch B, 30 watch C, 18 watch A and B, 16 watch B and C, 15 watch A and C, 8 watch all three. Find those who watch exactly one channel.
94. Out of 80 members: 50 play Tennis, 40 play Badminton, 10 play neither. How many play both?
95. In an office: 60% use Windows, 40% use Mac, 20% use both. What % use at least one?
96. 150 students: 80 enrolled in Course A, 70 in Course B, 60 in Course C, 30 in A and B, 25 in B and C, 20 in A and C, 10 in all three. How many enrolled in exactly two courses?
97. In a survey of cars: 120 have AC, 100 have Power Windows, 80 have both. Total cars surveyed = 150. How many have neither?
98. Out of 200: 110 read Magazine X, 90 read Magazine Y, 120 read Magazine Z, 40 read X and Y, 50 read Y and Z, 45 read X and Z, 20 read all. How many read exactly two magazines?
99. In a town: 1000 people. 400 have Car, 300 have Bike, 200 have both. How many have at least one vehicle?
100. 80% of people eat Veg, 60% eat Non-veg. If everyone eats at least one type, what % eat both?

📝 PRACTICE QUESTIONS - RELATIONS (50 Questions)

Section E: Basic Level - Relations Fundamentals (Q101-Q120)

101. If A = {1, 2} and B = {3, 4}, write A × B.

102. If A = {a, b} and B = {1, 2, 3}, find n(A × B).

103. Let R = {(1, 2), (2, 3), (3, 4)}. Find domain of R.

104. Let R = {(1, 2), (2, 3), (3, 4)}. Find range of R.

105. If A = {1, 2, 3}, what is the identity relation on A?

106. Give an example of empty relation.

107. If A = {1, 2}, write universal relation from A to A.

108. How many relations are possible from A to B if n(A) = 2 and n(B) = 3?

109. If R = {(1, 2), (2, 1), (3, 3)}, is R symmetric?

110. If R = {(1, 1), (2, 2), (3, 3)}, is R reflexive?

111. Define reflexive relation with example.

112. Define symmetric relation with example.

113. Define transitive relation with example.

114. Is the relation R = {(1, 1), (2, 2)} reflexive on A = {1, 2, 3}?

115. What is an equivalence relation?

116. If R = {(a, b) : a = b, a, b ∈ N}, name the relation.

117. Let A = {1, 2, 3} and R = {(1, 2), (2, 3)}. Find R^{-1}.

118. Is empty relation symmetric? Justify.

119. Is empty relation transitive? Justify.

120. If $n(A \times B) = 12$ and $n(B) = 3$, find $n(A)$.

Section F: Average Level - Types of Relations (Q121-Q135)

121. Check if R = {(1, 1), (1, 2), (2, 1), (2, 2)} is reflexive on A = {1, 2}.

122. Check if R = {(1, 2), (2, 1), (3, 4), (4, 3)} is symmetric.

123. Check if R = {(1, 2), (2, 3), (1, 3)} is transitive.

124. Let A = {1, 2, 3} and R = {(1, 1), (2, 2), (3, 3), (1, 2), (2, 1)}. Check if R is equivalence relation.

125. If R is defined on set of integers as R = {(a, b) : a - b is even}, prove R is equivalence relation.

126. Let A = {1, 2, 3, 4} and R = {(a, b) : $a \leq b$}. Is R reflexive?

127. Let A = {1, 2, 3, 4} and R = {(a, b) : $a < b$}. Is R reflexive?

128. Let R = {(a, b) : a divides b} on set {1, 2, 3, 4}. Is R transitive?

129. Give an example of relation which is symmetric but not reflexive.

130. Give an example of relation which is reflexive but not symmetric.

131. Find domain and range of R = {(x, y) : $y = 2x + 1$, $x \in \{0, 1, 2\}$}.

132. If R = {(a, b) : $|a - b| = 2$} on A = {1, 2, 3, 4, 5}, write R in roster form.

133. Let R be relation on N defined by R = {(a, b) : $a + b = 6$}. Write R.

134. Check if "is greater than" relation on natural numbers is transitive.

135. Is the relation "is perpendicular to" in the set of all lines in a plane symmetric?

Section G: Above Average - Advanced Relations (Q136-Q150)

136. Prove that "is equal to" relation on any set is an equivalence relation.

137. Let A = Z (integers) and R = {(a, b) : $a^2 = b^2$}. Prove R is equivalence relation.

138. Show that relation R = {(a, b) : a ≡ b (mod 3)} on Z is equivalence relation.

139. Let L be set of all lines in a plane. R = {(l_1, l_2) : l_1 is parallel to l_2}. Is R equivalence?

140. If A = {1, 2, 3}, how many reflexive relations are possible on A?

141. If A = {1, 2, 3}, how many symmetric relations are possible on A?

142. Let R and S be two equivalence relations on set A. Is R ∩ S also equivalence? Prove.

143. Let R be relation on set A. If R is symmetric and transitive, is it reflexive? Justify.

144. If R = {(a, b) : a ≤ b^2} on N, check if R is reflexive, symmetric, or transitive.

145. Let A = {1, 2, 3, 4} and R = {(a, b) : |a - b| ≤ 1}. Check for reflexive, symmetric, transitive.

146. Prove: If R is symmetric, then $R^{-1} = R$.

147. If R_1 and R_2 are two relations from A to B, prove: $(R_1 \cup R_2)^{-1} = R_1^{-1} \cup R_2^{-1}$.

148. Find number of relations on set {a, b, c} which are both symmetric and reflexive.

149. Let R be relation on R (real numbers) defined by R = {(a, b) : a - b + √3 is irrational}. Is R transitive?

150. Give example of a relation which is reflexive and symmetric but not transitive.

CASE STUDY BASED QUESTIONS (MCQs)

Case Study 1: Student Survey Analysis

Read the following:

In a school, a survey was conducted among 100 students about their favorite subjects. The findings were: 60 students like Mathematics, 50 like Science, 45 like English. Additionally, 25 students like both Mathematics and Science, 20 like both Science and English, 15 like both Mathematics and English, and 10 students like all three subjects.

Based on the above information, answer the following:

1. How many students like only Mathematics?
   (a) 30 (b) 35 (c) 40 (d) 45
2. How many students like Mathematics or Science but not English?
   (a) 60 (b) 65 (c) 70 (d) 75
3. How many students like exactly two subjects?
   (a) 20 (b) 25 (c) 30 (d) 35

4. How many students like at least one subject?

   (a) 85 (b) 90 (c) 95 (d) 100

Case Study 2: Digital Platforms Usage

> **Read the following:**
>
> A survey of 200 people was conducted to find their usage of three social media platforms: Facebook (F), Instagram (I), and Twitter (T). The results showed: 120 use Facebook, 100 use Instagram, 80 use Twitter, 50 use both Facebook and Instagram, 40 use both Instagram and Twitter, 45 use both Facebook and Twitter, and 25 use all three platforms.

Based on the above information, answer the following:

5. How many people use only Facebook?

   (a) 50 (b) 55 (c) 60 (d) 65

6. How many people use exactly two platforms?

   (a) 60 (b) 65 (c) 70 (d) 75

7. How many people use at least one platform?

   (a) 155 (b) 160 (c) 165 (d) 170

8. How many people don't use any of these platforms?

   (a) 30 (b) 35 (c) 40 (d) 45

Case Study 3: Cartesian Product and Relations

Read the following:

Let A = {1, 2, 3} and B = {4, 5}. A relation R is defined from A to B such that R = {(x, y) : x + y is odd}.

Based on the above information, answer the following:

9. What is n(A × B)?

   (a) 5 (b) 6 (c) 8 (d) 9

10. Which of these ordered pairs belong to R?

    (a) (1, 4) (b) (2, 5) (c) (3, 4) (d) All of these

11. What is the range of R?

    (a) {4} (b) {5} (c) {4, 5} (d) {1, 2, 3}

12. What is n(R)?

    (a) 2 (b) 3 (c) 4 (d) 6

Case Study 4: Library Books Classification

Read the following:

A library has books classified into three categories: Fiction (F), Non-Fiction (N), and Biography (B). Out of 500 books: 250 are Fiction, 200 are Non-Fiction, 150 are Biography, 80 are both Fiction and Non-Fiction, 60 are both Non-Fiction and Biography, 50 are both Fiction and Biography, and 30 books belong to all three categories.

Based on the above information, answer the following:

13. How many books are only Fiction?

(a) 120 (b) 130 (c) 140 (d) 150

14. How many books belong to at least two categories?

(a) 130 (b) 140 (c) 150 (d) 160

15. How many books belong to exactly one category?

(a) 290 (b) 300 (c) 310 (d) 320

16. How many books belong to at least one category?

(a) 410 (b) 420 (c) 430 (d) 440

Case Study 5: Equivalence Relations

> **Read the following:**
>
> Let A = {1, 2, 3, 4, 5} and R be a relation on A defined by R = {(a, b) : a - b is divisible by 2}.

Based on the above information, answer the following:

17. Is (1, 1) ∈ R?

(a) Yes (b) No (c) Cannot determine (d) None of these

18. Is R reflexive?

(a) Yes (b) No (c) Cannot determine (d) None of these

19. If (2, 4) ∈ R, then (4, 2) ∈ R. Is R symmetric?

(a) Yes (b) No (c) Cannot determine (d) None of these

20. Is R an equivalence relation?

(a) Yes (b) No (c) Cannot determine (d) None of these

💡 ASSERTION-REASON QUESTIONS (20 Questions)

Instructions for Assertion-Reason Questions:

Each question contains two statements: Assertion (A) and Reason (R). Choose the correct option:

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

(b) Both A and R are true but R is NOT the correct explanation of A

(c) A is true but R is false

(d) A is false but R is true

Assertion-Reason Questions on Sets

1. **Assertion (A):** If A = {1, 2, 3}, then number of subsets of A is 8.

   Reason (R): If a set has n elements, it has 2^n subsets.

2. **Assertion (A):** The set $\{x : x^2 = -1, x \in R\}$ is an empty set.

   Reason (R): Square of a real number cannot be negative.

3. **Assertion (A):** If $A \subset B$, then $A \cup B = B$.

   Reason (R): Union of a set with its subset is the larger set.

4. **Assertion (A):** If n(A) = 3 and n(B) = 4, then n(A × B) = 12.

   Reason (R): n(A × B) = n(A) + n(B).

5. **Assertion (A):** If A and B are disjoint sets, then $n(A \cup B) = n(A) + n(B)$.

   Reason (R): Disjoint sets have no common elements.

6. **Assertion (A):** (A ∪ B)' = A' ∩ B'.
   Reason (R): This is De Morgan's Law.
7. **Assertion (A):** ∅ is a subset of every set.
   Reason (R): Empty set has no elements to contradict subset condition.
8. **Assertion (A):** If A = {1, 2} and B = {1, 2}, then A = B.
   Reason (R): Two sets are equal if they have same elements.
9. **Assertion (A):** n(P(∅)) = 1.
   Reason (R): Power set of empty set contains only empty set.
10. **Assertion (A):** If A ∩ B = A, then A ⊂ B.
    Reason (R): Intersection of two sets is always subset of both sets.

Assertion-Reason Questions on Relations

11. **Assertion (A):** Empty relation is a symmetric relation.
    Reason (R): For empty relation, if (a, b) ∈ R, then (b, a) ∈ R is vacuously true.
12. **Assertion (A):** Identity relation is an equivalence relation.
    Reason (R): Identity relation is reflexive, symmetric, and transitive.
13. **Assertion (A):** If n(A) = m and n(B) = n, then number of relations from A to B is 2^{mn}.
    Reason (R): A relation from A to B is a subset of A × B.
14. **Assertion (A):** "Is equal to" relation on any set is an equivalence relation.
    Reason (R): It satisfies reflexive, symmetric, and transitive properties.
15. **Assertion (A):** Domain of R^{-1} = Range of R.
    Reason (R): Inverse relation interchanges domain and range.

16. **Assertion (A):** Universal relation on a set A is symmetric.

    Reason (R): In universal relation, all ordered pairs from A × A are present.

17. **Assertion (A):** If R is reflexive on A, then every element of A must relate to itself.

    Reason (R): Reflexive means (a, a) ∈ R for all a ∈ A.

18. **Assertion (A):** "Is less than" relation on natural numbers is transitive.

    Reason (R): If a < b and b < c, then a < c.

19. **Assertion (A):** A relation can be both symmetric and transitive but not reflexive.

    Reason (R): Empty relation is symmetric and transitive but not reflexive on non-empty set.

20. **Assertion (A):** If R and S are equivalence relations on A, then R ∩ S is also an equivalence relation.

    Reason (R): Intersection preserves reflexive, symmetric, and transitive properties.

📝 ANSWER KEY - QUICK REFERENCE

SETS - Selected Answers:

Q1: (b) | Q2: (c) | Q3: {1,2,3,4,5} | Q4: {x:x is even natural number, x≤10} | Q5: 2

Q6: (b) | Q7: (c) | Q8: {A,E,I} | Q9: 3 | Q10: True

Q16: 4 | Q17: ∅,{a},{b},{a,b} | Q18: 15 | Q19: True | Q21: P(A)={∅,{1},{2},{1,2}}

Q31: {1,2,3,4,5} | Q32: {3} | Q33: ∅ | Q34: Yes | Q35: 40

Q46: {1,3,5} | Q47: {1,2} | Q48: {5,6} | Q49: No | Q61: 20

Q62: 5 | Q63: 30 | Q81: 150 | Q85: (a)30 (b)20 (c)75

RELATIONS - Selected Answers:

Q101: {(1,3),(1,4),(2,3),(2,4)} | Q102: 6 | Q103: {1,2,3} | Q104: {2,3,4}

Q105: {(1,1),(2,2),(3,3)} | Q108: 64 | Q109: Yes | Q110: Yes

Q121: Yes | Q122: Yes | Q123: Yes | Q136: Proof required

CASE STUDIES - Answers:

Study 1: Q1(a), Q2(b), Q3(c), Q4(b) | Study 2: Q5(a), Q6(b), Q7(c), Q8(b)

Study 3: Q9(b), Q10(d), Q11(c), Q12(b) | Study 4: Q13(d), Q14(a), Q15(c), Q16(b)

Study 5: Q17(a), Q18(a), Q19(a), Q20(a)

ASSERTION-REASON - Answers:

Q1: (a) | Q2: (a) | Q3: (a) | Q4: (c) | Q5: (a) | Q6: (a) | Q7: (a) | Q8: (a) | Q9: (a) | Q10: (a)

Q11: (a) | Q12: (a) | Q13: (a) | Q14: (a) | Q15: (a) | Q16: (a) | Q17: (a) | Q18: (a) | Q19: (b) | Q20: (a)

⚠️ COMMON MISTAKES TO AVOID:

- **Sets:**
  - Don't confuse ∈ (belongs to) with ⊂ (subset)
  - Remember: {a} ∈ P(A) but a ∉ P(A)
  - ∅ ≠ {∅} - Empty set is different from set containing empty set
  - In Venn diagrams, always find intersection first before solving
  - n(A ∪ B) = n(A) + n(B) only when sets are disjoint
- **Relations:**
  - Don't confuse domain with co-domain
  - Remember: (a, b) ≠ (b, a) in ordered pairs

- For reflexive: ALL elements must relate to themselves
- For transitive: Check ALL possible combinations
- $A \times B \neq B \times A$ (not commutative)

⏰ TIME MANAGEMENT FOR HOME EXAM:

- **1 Mark Questions (MCQs):** 1-2 minutes each
- **2 Mark Questions:** 3-4 minutes each (Direct formulas/definitions)
- **3 Mark Questions:** 5-7 minutes each (Venn diagrams/proofs)
- **4 Mark Questions:** 8-10 minutes each (Word problems with 3 sets)
- **5 Mark Questions:** 10-12 minutes each (Complete proofs/derivations)
- **Case Studies:** 6-8 minutes for 4 MCQs
- **Assertion-Reason:** 2-3 minutes each
- **Review Time:** Last 10-15 minutes for checking

Pro Tip: Draw Venn diagrams for all word problems - they save time and prevent errors!

🎯 FINAL PREPARATION CHECKLIST (2 Days Before Exam):

- ✓ Revise all types of sets (empty, singleton, finite, infinite, universal)
- ✓ Memorize all set operation formulas (union, intersection, complement, difference)
- ✓ Practice De Morgan's Laws - at least 5 questions
- ✓ Master the formula: $n(A \cup B) = n(A) + n(B) - n(A \cap B)$
- ✓ Practice Venn diagram problems with 2 sets - minimum 10 questions
- ✓ Practice Venn diagram problems with 3 sets - minimum 5 questions

- ✓ Understand difference between ∈ and ⊂ symbols clearly
- ✓ Revise Cartesian product and its properties
- ✓ Understand all types of relations (reflexive, symmetric, transitive)
- ✓ Practice checking equivalence relations - at least 5 questions
- ✓ Solve all case study questions twice
- ✓ Revise assertion-reason format and practice 10 questions
- ✓ Review common mistakes section carefully
- ✓ Practice drawing clear Venn diagrams with proper labeling
- ✓ Sleep well night before exam - Fresh mind = Better accuracy!

📚 QUICK REVISION FORMULAS:

Formula	Description
2^n	Number of subsets of a set with n elements
$2^n - 1$	Number of proper subsets
$n(A \cup B) = n(A) + n(B) - n(A \cap B)$	Union formula for two sets
$n(A \times B) = n(A) \times n(B)$	Cartesian product cardinality
$(A \cup B)' = A' \cap B'$	De Morgan's First Law
$(A \cap B)' = A' \cup B'$	De Morgan's Second Law
$A - B = A \cap B'$	Set difference

2^{mn}	Number of relations from set A (n elements) to B (m elements)

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