UNIT	01

SETS

Related Definitions and Formulae

Some Important Sets of Numbers:

(1) Set of Natural Numbers $N = \{1,2,3,\ldots\ldots\}$

(2) Set of Whole Numbers $W = \{0,1,2,\ldots\ldots\}$

(3) Set of Integers $Z = \{0, \pm1, \pm2, \pm3, \ldots\ldots\}$

(4) Set of Positive Prime Numbers $P = \{2,3,5,7,11,\ldots\ldots\}$

(5) Set of Odd Numbers $O = \{\pm1, \pm3, \pm5,\ldots\ldots\}$

(6) Set of Even Numbers $E = \{0, \pm2, \pm4, \pm6, \ldots\ldots\}$

(7) Set of Rational Numbers $Q = \{x/x = \frac{p}{q}; p, q \in z, q \neq 0\}$

(8) Set of Irrational Numbers $Q' = \{x/x \neq \frac{p}{q}; p, q \in z, q \neq 0\}$

(9) Set of Real Numbers $R = Q \cup Q'$

SET: Set is a Collection of **WELL** defined and **DISTINCT** objects".

Well defined means that a rule can be stated which determines either an object is a member of a set or not. Distinct means that each object of a set is different from all other objects of the set. We can not repeat a member in a set. For example $A = \{x \mid x \in Z^+ ; x < 5\}$ it says that set "A" has member such that they are positive integers and they are less than 5 i–e set A has members $A = \{1,2,3,4\}$ So in Set A the portion $[x \in Z^+ ; x < 5]$ is a rule which determines its members and each member is unique.

ELEMENT: Any thing belong to a Set is called an element (or member) of the Set.

Forms of Sets:

(1) Descriptive Form: A Set which described with the help of a statement is called descriptive form.

e.g. # N = The Set of natural numbers.

(2) Tabular Form: In this form we list the element of a set with in curley Bracket.

$$S = \{a,b,c,d\} \; ; \; T = \{1,2,3\}$$

(3) Set-Builder Form: By enclosing within Curley bracket a rule that determines its elements is said to be set builder form.

e.g. # $A = \{ x \mid x \in N \; ; \wedge \; ; 100 \leq x \leq 150 \}$

$A = \{ 100, 101, \ldots\ldots\ldots, 150\}$

(4) Venn Diagram: Sets can also be represent graphically using venn diagrams. In venn diagrams the Universal Set U, which contains all the elements of the Subsets under consideration, is usually represented by a rectangle. Inside this rectangle, Circles are used to represent sets.

SOME IMPORTANT DEFINITIONS:

Singleton Set: A Set having only one element is called singleton set.

Null/Empty Set: A set having does not contain any element is called Null/empty set it is denoted by { } or ϕ

e.g # $A = \{ x \mid x$ is 100 years old man living in Pakistan $\}$

$B = \{ x \mid x$ is a man with 200 feet height $\}$

Finite Set: A set in which the process of counting it's elements terminates is called a finite set.

e.g # $A = \{ 1, 2, 3, \ldots\ldots\ldots, 60\}$

Infinite Set: If the process of counting the elements of a set does not terminate then set is called an infinite set.

e.g # N = Set of Natural numbers.

Equal Sets: Two sets are said to be equal if and only if they have the same elements.

e.g # $A = \{a, b, c, d\}$ and

$B = \{b, c, a, d\}$ are equal Sets

i − e $A = B$ Thus $A = B$ iff $A \subseteq B$ and $B \subseteq A$.

Equivalent Sets: Two sets A and B are said to be equivalent, denoted by $A \sim B$ if they have same number of elements.

e.g # $A = \{1,2,3\}$ and $B = \{a,b,c\}$ then $A \sim B$

Note: If A, B and C are three sets then $A \sim B$ and $B \sim C \Rightarrow A \sim C$. This is called the transitive property of equivalence of sets.

Subset: A set A is a subset of a set B denoted by $A \subseteq B$, if every element of A is also an element of B. symbolically $A \subseteq B$.

Note: (i) Null set, ϕ is a subset of every set.

(ii) Every set is a subset of itself.

Power Set: The set of all possible subsets of a set A is called power set of A and is denoted by p(A). The total numbers of subsets is find out by 2^n. Where n = number of elements in a set.

Proper Subset: A set A is a proper Subset of a Set B denoted by $A \subset B$ if A is a subset of B and if there exists atleast one element in B that is not in A.

e.g # If $A = \{1,2,3\}$ and $B = \{1,2,3,4\}$

then A is proper subset of B i − e $A \subset B$.

Note: If A is a subset of B and B is a subset of C, then A is a subset of C i − e $A \subseteq B$ and $B \subseteq C \Rightarrow A \subseteq C$ This is called the transitive property of subsets.

Improper Subset: A set is called improper subset. If both sets are one by one equivalent to each other.

e.g # $A = \{a,b,c,d\}$; $B = \{b,c,a,d\}$

then set A is an improper subset of set B.

Note: Each Set is an improper subset of itself. Infact, the only improper subset of a set is the set itself.

OPERATIONS ON TWO SETS:

Union of Two Sets: The Union of the Sets A and B, denoted by AUB is the Set that Contains those elements which are contained in A or B or both.

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

Intersection of Two Sets: The intersection of sets A and B, denoted by A∩B, is the set that contains those elements which are contained in both A and B.

$$A \cap B = \{ x \mid x \ \ A \text{ and } x \in B \}$$

Difference of Two Sets: The difference of Sets A and B, denoted by A − B is the set containing those elements that are in A but not in B.

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

Symmetric Difference of Two Sets: The symmetric difference of sets A and B, denoted by A Δ B, is the set containing those elements which are either in A or in B but not in both A and B.

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

Universal Set: A Set which contains all the sets under consideration is called a universal set. Usually it is denoted by **U**.

Complement of a Set: Let **U** be a Universal set and let $A \subset \mathbf{U}$. The Complement of Set A, denoted by A^c or A', is the set containing those elements of **U**, which are not in A.

Disjoint Sets: If the intersection of two sets is the empty set then the sets are said to be disjoint sets.

i − e $A \cap B = \phi$

Fundamental Properties of Union and Intersection:

(1) $A \cup B = B \cup A$
(Commutative property of union)

(2) $A \cap B = B \cap A$
(Commutative property of Intersection)

(3) $A \cup (B \cup C) = (A \cup B) \cup C$
(Associative property of Union)

Domain and Range of a Binary Relation: The Set of the first elements of all ordered pairs in a relation R from a. Set A to a Set B is called the domain of the relation R. The Set of the second elements of all the ordered pairs in the relation is called the range of the relation R.

Domain of R is denoted by Dom R and range of R is denoted by Range R.

Function: Let A and B be any two sets and R be a binary relation from A to B. Then R is called a function from A to B if

(i) Dom R = A

(ii) Every element of A is associated with exactly one element of B under R i – e $(a,b) \in R$, $(a,b') \in R$ imply that $b = b'$.

If a relation is a function then it is usually denoted by f,g etc.

If f is a function from A to B, it is written as $f: A \longrightarrow B$ it is read as f is a function from A to B.

Note: If $f : A \longrightarrow B$ is a function from A to B and pair (a,b), $a \in A$ and $b \in B$ is in f. Then b is called the image of a under f. It is denoted by $f(a) = b$.

Types of Function:

(1) Onto Function: A function f from A to B is called an onto function if Range f = B.

(2) One–One fuction: A function f from A to B is said to be one–one if distinct elements of set A are associated with distinct elements of Set B.

(3) One–One and onto function: A function f from Set A to set B is called a one – one and onto function it is both one–one and onto.

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

(Associative property of Intersection)

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

(Distributive property of Union over Intersection)

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

(Distributive property of intersection over union)

De Morgan's Laws: If we have two sets A and B, be the subsets of (Universal Set) then

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

Ordered Pair: An Ordered set of two elements is called an ordered pair.

e.g # (a,b), the first component is "a" and the second component is "b"

The Cartesian Product of Two Sets: The Cartesian product of any set A with any other set B is the set of all ordered pairs (a,b) where $a \in A$ and $b \in B$ it is denoted by $A \times B$ and is read as "A Cross B" Symbolically.

$$A \times B = \{(a,b) | a \in A; b \in B\}$$

Note:(1) The ordered pairs (a,b) and (b,a) are not the same unless $a = b$

(2) Two ordered pairs (a,b) and (c,d) are equal if and only if $a = c$, $b = d$.

(3) if either A or B is empty then $A \times B = \phi$

(4) $A \times B \neq B \times A$ Unless $A = B$

(5) If the number of elements in sets A and B are m and n, respectively, then the number of elements in $A \times B$ is mn.

Binary Relation: A binary relation from a set A to a set B is just a subset of $A \times B$.

Thus, every subset of $A \times B$ is a binary relation from A to B.

In particular, a subset of $A \times A$ is called a binary relation in A.

EXERCISE 1.1

Q1. Use both tabular and set builder forms to specify the following.

(a) The set of positive integers greater than 2 and less than 6.

<u>**Solution:**</u> Tabular form $A = \{3,4,5\}$

Set builder form $A = \{x|x \in z^{+} \wedge 2 < x < 6\}$

(b) The Set of positive integers less than 20 that are divisible by 5.

<u>**Solution:**</u> Tabular form $A = \{5,10,15\}$

Set builder from $A = \{x|x \in z^{+} \wedge x$ multiple of 5 less than $20\}$

(c) The set of natural numbers between 4 and 12.

<u>**Solution:**</u> Tabular form $A = \{5,.6,7,8,9,10,11\}$

Set builder from $A = \{x|x \in N \wedge 4 < x < 12\}$

(d) A set of first six positive prime numbers.

<u>**Solution:**</u> Tabular form $A = \{2,3,5,7,11,13\}$

Set builder from $A = \{ x|x \in P \,;\, 2 \leq x \leq 13\}$

Q2. Which of the following sets are the Null sets?

A = {x|x is a letter before "a" in the English alphabet}

Ans. Null set

$B = \{x|x + 5 = 5\}$

Ans. B {0} Not Null set

C = {x|x is less than 7 and greater than 8}

Ans. Null set

D = {x|x is past President of • • • who was a woman}

Ans. Null set

Q3. Which of these sets are finite and which of these are infinite?

(a) The months of a year.

Ans. Finite

(b) **The days in a year.**

Ans. Finite

(c) **The students of your class.**

Ans. Finite

(d) **$\{2,4,6,8,10,......\}$**

Ans. Infinite

(e) **The set of lines passing through a point.**

Ans. Infinite

(f) **The set of lines passing through two given points.**

Ans. Finite

Q4. **Given $S = \{x|x$ is a positive integer$\}$, find proper subsets of S that are also subsets of A, where $A = \{x|x$ is an integer less than 3$\}$**

Solution: $S = \{1,2,3,......\}$

Proper subsets of S are

$= \{\ \}, \{1\}, \{2\}, \{3\}.......$

given that $A = \{1,2\}$

subsets of A are

$= \{\ \}, \{1\}, \{2\}, \{1,2\}$

According to given statement required proper subsets are $\{\ \}, \{1\}, \{2\}, \{1,2\}$. **Ans.**

Q5. If $A = \{a, b, c, d\}$ find:

(a) **Proper subsets of A**

Solution: $\{\ \}, \{a\}, \{b\}, \{c\}, \{d\}, \{a,b\}, \{a,c\}, \{a,d\}, \{b,c\}, \{b,d\}, \{c,d\}, \{a,b,c\}, \{a,b,d\}, \{b,c,d\}, \{a,c,d\}$ **Ans.**

(b) **An improper subset of A.**

Solution: $\{a,b,c,d\}$ **Ans.**

(c) **Two sets B and C that are subsets of A such that $B \subset C$**

Solution: Let $B = \{a,b\}$ and $C = \{a,b,c\}$ this follows $B \subset C$ **Ans.**

(d) **Two sets B and C that are subsets of A uch that $B \subseteq C$**

Solution: let $B = \{a,b\}$

$C = \{a,b,c\}$

this follows $B \subseteq C$ **Ans.**

Q6. Find all the subsets of A = {a,b,c,d} Hence, or otherwise, find |P(A)|

Solution: P(A) = { { }, {a}, {b}, {c}, {d}, {a,b}, {a,c}, {a,d}, {b,c}, {b,d}, {c,d}, {a,b,c}, {a,b,d}, {a,c,d}, {b,c,d}, {a,b,c,d} } **Ans.**

Q7. Is there any set which has no proper subset? If yes, specify the set.

Ans. Yes, a Null set has no proper subset i–e { }

Q8. Find a set which has only one proper subset.

Solution: A set which has only one element show the only one proper subset.

Let A = {1}

Subset of A is { } Ans.

Q9. If n (A) = 10 then n [P(A)]= _______.

Ans. $= 2^n = 2^{10} = 1024$

Q10. Use the set builder form to give an example of a Null set.

Solution: If B is a Null set then in set builder notation it can be written as:

B = {x ∈ p | x = 4} **Ans.**

Q11. Consider the set A = {1,2,3,4}. Find a proper subset B of A then find a proper subset C of B, then find a proper subset D of C.

Solution: Let proper subset is B = {1,2,3} B⊂A. proper subset of B is C ⇒ C = {1,2} i–e C⊂B. Again proper subset of C is D ⇒ D {1} i–e D⊂C. **Ans.**

Q12. Which of the following are equivalent sets?

(a) **A = {a,b,c}, B = {1,2,3}**

Solution: ∴ n (A) = n (B) = 3 So A~B

(b) **A = {1,2,3,4}, B = {a,b,c}**

Solution: ∴ n (A) ≠ n (B) so A ≁ B.

(c) **$A = \{x | x$ is a positive integers less than $6\}$**

$B = \{a,e,i,o,u\}$

<u>Solution:</u> $A = \{1,2,3,4,5\}$

$B = \{a,e,i,o,u\}$

$\therefore n(A) = n(B) = 5$

So $A \sim B$

EXERCISE 1.2

Given that the sets A = {f,a,c,e} and B = {e,g,d,f} are subsets of the universal set U = {a,b,c,d,e,f,g} list the elements of.

(1) A'

Solution:

$U-A = \{a,b,c,d,e,f,g\} - \{f,a,c,e\}$

$A' = \{b,d,g\}$ **Ans.**

(2) B'

Solution:

$U-B = \{a,b,c,d,e,f\} - \{e,g,d,f\}$

$B' = \{a,b,c\}$ **Ans.**

(3) $A\cap B$

Solution:

$A\cap B = \{f,a,c,e\} \cap \{e,g,d,f\}$

$A\cap B = \{e,f\}$ **Ans.**

(4) $(A\cup B)'$

Solution:

$A\cup B = \{f,a,c,e\} \cup \{e,g,d,f\}$

$A\cup B = \{a,c,d,e,f,g\}$

$U-(A\cup B) = \{a,b,c,d,e,f,g\} - \{a,c,d,e,f,g\}$

$(A\cup B)' = \{b\}$ **Ans.**

(5) $A\cap B'$

Solution:

$U - B = \{a,b,c,d,e,f,g\} - \{e,g,d,f\}$

$B' = \{a,b,c\}$

$A \cap B' = \{f,a,c,e\} \cap \{a,b,c\}$

$A \cap B' = \{a,c\}$ **Ans.**

(6) **$A' \cap B'$**

Solution:

$U - A = \{a,b,c,d,e,f,g\} - \{f,a,c,e\}$

$A' = \{b,d,g\}$

$U - B = \{a,b,c,d,e,f,g\} - \{e,g,d,f\}$

$B' = \{a,b,c\}$

$A' \cap B' = \{b,d,g\} \cap \{a,b,c\}$

$A' \cap B' = \{b,d,g\} \cap \{a,b,c\}$

$A' \cap B' = \{b\}$ **Ans.**

A

(7) **$U \cup \phi$**

Solution:

$U \cup \phi = \{a,b,c,d,e,f,g\} \cup \{\ \}$

$= \{a,b,c,d,e,f,g\}$

$U \cup \phi =$ **U Ans.**

(8) **$U \cap \phi$**

Solution:

$U \cap \phi = \{a,b,c,d,e,f,g\} \cap \{\ \}$

$U \cup \phi = \{\ \}$ **Ans.**

Given the sets A = {x|x is positive even integer less than 10} and B = {x|x is positive odd integer less than 10} are subsets of the universal set.

U = {x | x is a positive integer less than 10} list the elements of

(9) **$A \cup B'$**

Solution:

In tabular form

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

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

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

$B' = \{2,4,6,8\}$

$AUB' = \{2,4,6,8\} \cup \{2,4,6,8\}$

$AUB' = \{2,4,6,8\}$ **Ans.**

(10) $A' \cap B$

Solution:

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

$A' = \{1,3,5,7,9\}$

$A' \cap B = \{1,3,5,7,9\} \cap \{1,3,5,7,9\}$

(11) $A' \cap B'$

Solution:

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

$A' = \{1,3,5,7,9\}$

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

$B' = \{2,4,6,8\}$

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

$A' \cap B' = \{\ \}$

(12) $A \Delta B$

Solution:

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

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

(13) $A - B'$

Solution:

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

$B' = \{2,4,6,8\}$

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

$A - B' = \{\ \}$

(14) $A' \Delta B$

Solution:

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

$A' = \{1,3,5,7,9\}$

$A' \Delta B = \{1,3,5,7,9\} \Delta \{1,3,5,7,9\}$

$A' \Delta B = \{\ \}$

(15) $(A' \cap B)'$

Solution:

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

$A' = \{1,3,5,7,9\}$

$A' \cap B = \{1,3,5,7,9\} \cap \{1,3,5,7,9\}$

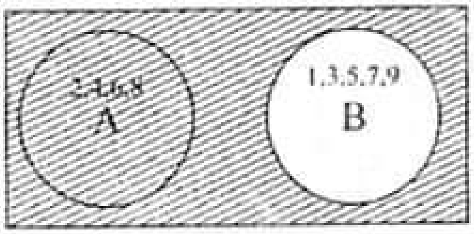
$A' \cap B = \{1,3,5,7,9\}$

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

$(A' \cap B)' = \{2,4,6,8\}$

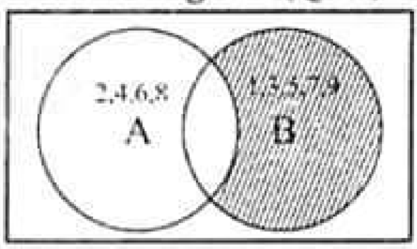
Q16. Draw the venn diagrams for the sets in Questions # 9,10,11,12,13,14,15

Venn diagram (Q.9)



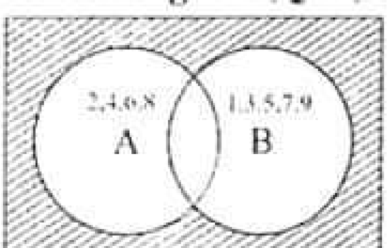
$A \cup B'$ is shaded

Venn diagram (Q.10)



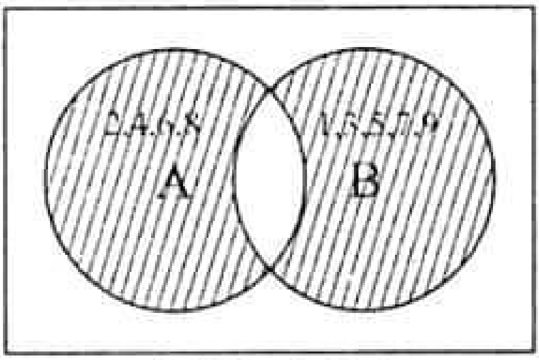
$A' \cap B$ is shaded

Venn diagram (Q.11)



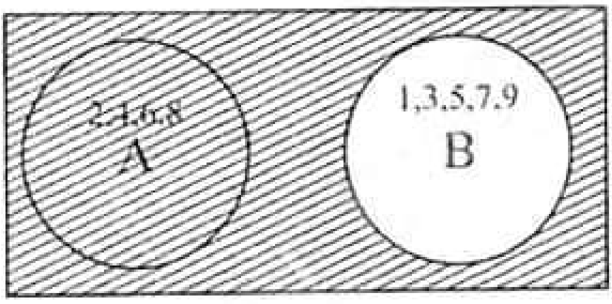
$A' \cap B'$ is shaded

Venn diagram (Q.12)



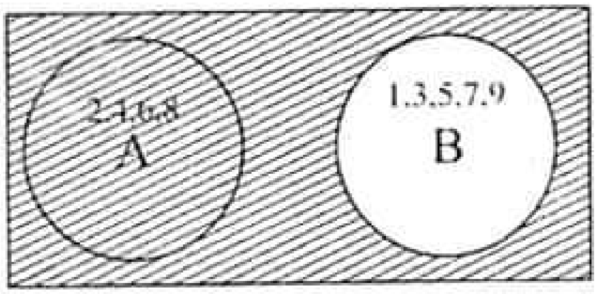
AΔB is shaded

Venn diagram (Q.13)



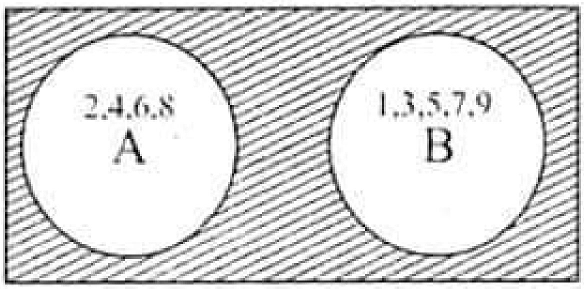
A–B′ is shaded

Venn diagram (Q.14)



A′ Δ B is shaded

Venn diagram (Q.15)



(A′ ∩ B)′ is shaded

If A = {1,2,3,4} and B = {2,4,6,8} show that:

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

<u>Solution:</u> Taking L.H.S

$$
\begin{aligned}
L.H.S &= A\Delta B \\
&= \{1,2,3,4\} \Delta \{2,4,6,8\} \\
&= \{1,3,6,8\} \text{———} (1) \\
A\cup B &= \{1,2,3,4\} \cup \{2,4,6,8\} \\
A\cup B &= \{1,2,3,4,6,8\} \\
A\cap B &= \{1,2,3,4\} \cap \{2,4,6,8\} \\
A\cap B &= \{2,4\} \\
R.H.S &= (A\cup B) - (A\cap B) \\
&= \{1,2,3,4,6,8\} - \{2,4\} \\
&= \{1,3,6,8\} \text{———} (2)
\end{aligned}
$$

By (1) and (2)

$A\Delta B = (A\cup B) - (A\cap B)$ **Proved.**

(18) $A\Delta B = (A-B) \cup (B-A)$

<u>Solution:</u> Taking L.H.S

$$
\begin{aligned}
L.H.S &= A\Delta B \\
&= \{1,2,3,4\} \Delta \{2,4,6,8\} \\
&= \{1,3,6,8\} \text{———} (1) \\
A - B &= \{1,2,3,4\} - \{2,4,6,8\} \\
A - B &= \{1,3\} \\
B - A &= \{2,4,6,8\} - \{1,2,3,4\} \\
B - A &= \{6,8\} \\
R.H.S &= (A - B) \cup (B - A) \\
&= \{1,3\} - \{6,8\} \\
&= \{1,3,6,8\} \text{———} (2)
\end{aligned}
$$

By (1) and (2)

$A\Delta B = (A\cup B) - (A\cap B)$ **Proved.**

(19) $\mathbf{A - B = A - (A \cap B)}$

<u>Solution:</u> **Taking L.H.S**

$$
\begin{aligned}
L.H.S &= A - B \\
&= \{1,2,3,4\} - \{2,4,6,8\} \\
&= \{1,3\} \text{——} (1) \\
A \cap B &= \{1,2,3,4\} \cap \{2,4,6,8\} \\
A \cap B &= \{2,4\} \\
R.H.S &= A - (A \cap B) \\
&= \{1,2,3,4\} - \{2,4\} \\
&= \{1,3\} \text{——} (2)
\end{aligned}
$$

By (1) and (2)

$A - B = A - (A \cap B)$ **Proved.**

Q20. If $U = \{1,2,3,\ldots\ldots, 20\}$, $A = \{1,2,4,8,10,16,20\}$ and $B=\{2,6,8,10,14,18\}$ verify De Morgan's laws.

<u>Solution:</u> **(1) $(A \cup B)' = A' \cap B'$**

For L.H.S

$$
\begin{aligned}
A \cup B &= \{1,2,4,8,10,16,20\} \cup \{2,6,8,10,14,18\} \\
A \cup B &= \{1,2,4,8,10,14,16,18,20\} \\
U-(A \cup B) &= \{1,2,3,\ldots\ldots,20\} - \{1,2,4,8,10,14,16,18,20\} \\
(A \cup B)' &= \{5,6,7,9,11,12,13,14,15,17,19\} \text{——} (1)
\end{aligned}
$$

For R.H.S

$$
\begin{aligned}
U - A &= \{1,2,3,4,5,\ldots\ldots,20\} - \{1,2,4,8,10,16,20\} \\
A' &= \{3,5,6,7,9,11,12,13,14,15,17,18,19\} \\
U - B &= \{1,2,3,4,5,\ldots\ldots,20\} - \{2,4,6,8,10,14,18\} \\
B' &= \{1,3,5,7,9,11,12,13,15,16,17,19\} \\
A' \cap B' &= \{3,5,6,7,9,11,12,13,14,15,17,18,19\} \cap \\
&\quad \{1,3,5,7,9,11,12,13,15,16,17,19\} \\
A' \cap B' &= \{5,6,7,9,11,12,13,14,15,17,19\} \text{——} (2)
\end{aligned}
$$

By (1) and (2)

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

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

<u>Solution:</u> For L.H.S.

$A \cap B = \{1, 2, 4, 8, 10, 16, 20\} \cap \{2, 6, 8, 10, 14, 18\}$

$A \cap B = \{2, 8, 10\}$

$U - (A \cap B) = \{1, 2, 3, \ldots\ldots\ldots\ldots 20\} - \{2, 8, 10\}$

$(A \cap B)' = \{1, 3, 4, 5, 6, 7, 9, 11, 12, 13, 14,$
$15, 16, 17, 18, 19, 20\}$ -------------------- (1)

FOR R.H.S

$U - A = \{1, 2, 3, 4, 5, \ldots\ldots, 20\} - \{1, 2, 4, 8, 10, 16, 20\}$

$A' = \{3, 5, 6, 7, 9, 11, 12, 13, 14, 15, 17, 18, 19\}$

$U - B = \{1, 2, 3, 4, 5, \ldots\ldots, 20\} - \{2, 4, 6, 8, 10, 14, 18\}$

$B' = \{1, 3, 5, 7, 9, 11, 12, 13, 15, 16, 17, 19\}$

$A' \cup B' = \{3, 5, 6, 7, 9, 11, 12, 13, 14, 15, 17, 18, 19\}$
$\cup \{1, 3, 5, 7, 9, 11, 12, 13, 15, 16, 17, 19\}$

$A' \cup B' = \{1, 3, 5, 6, 7, 9, 11, 12, 13, 14,$
$15, 16, 17, 18, 19, 20\}$ --------------- (2)

by (1) & (2)

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

Q21. Verify the commutative property of union and intersection for the following sets.

(a) $A = \{1,2,3,4,5\}$, $B = \{3,5,7,9\}$

<u>Solution:</u> Commutative property of Union is $A \cup B = B \cup A$

Taking L.H.S

$A \cup B = \{1,2,3,4,5\} \cup \{3,5,7,9\}$

$A \cup B = \{1,2,3,4,5,7,9\}$ —— (1)

Taking R.H.S

$B \cup A = \{3,5,7,9\} \cup \{1,2,3,4,5\}$

$B \cup A = \{1,2,3,4,5,7,9\}$ —— (2)

By (1) and (2) $A \cup B = B \cup A$

Commutative property for intersection $A \cap B = B \cap A$

Taking L.H.S

L.H.S $= A \cap B$

$= \{1,2,3,4,5\} \cap \{3,5,7,9\}$

$= \{3,5\}$ —— (1)

Taking R.H.S

R.H.S $= B \cap A$

$= \{3,5,7,9\} \cap \{1,2,3,4,5\}$

$= \{3,5\}$ —— (2)

By (1) and (2)

$A \cap B = B \cap A$ **Proved.**

(b) **A** $= \{x|x \in z^{+}$ **and** $x \leq 5\}$

B $= \{x|x \in z$ **and** $1 \leq x \leq 4\}$

Solution: **A** $= \{1,2,3,4,5\}$

B $= \{1,2,3,4\}$

Commutative property of union. $A \cup B = B \cup A$

Taking L.H.S

L.H.S $= A \cup B$

$= \{1,2,3,4,5\} \cup \{1,2,3,4\}$

$= \{1,2,3,4,5\}$ —— (1)

Taking R.H.S

R.H.S $= B \cup A$

$= \{1,2,3,4\} \cup \{1,2,3,4,5\}$

$= \{1,2,3,4,5\}$ —— (2)

By (1) and (2)

$A \cup B = B \cup A$

Commutative property of intersection $A \cap B = B \cap A$

Taking L.H.S

L.H.S $= A \cap B$

$= \{1,2,3,4,5\} \cap \{1,2,3,4\}$

$= \{1,2,3,4\}$ —— (1)

Taking R.H.S

R.H.S $= B \cap A$

$= \{1,2,3,4\} \cap \{1,2,3,4,5\}$

$= \{1,2,3,4\}$ —— (2)

By (1) and (2)

$A \cap B = B \cap A$

Q22. Verify the following properties for the sets given below.

(i) Associative property of union and of intersection.

(ii) Distributive properties of union over intersection.

(iii) Distributive property of intersection over union.

(a) A = {1,2,3,4,5}, B = {2,4,6,8}; c = {4,8,10,12}

Solution:

(i) Associative property of union and of intersection.

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

Taking L.H.S

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

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

$A \cup (B \cup C) = \{1,2,3,4,5\} \cup \{2,4,6,8,10,12\}$

$= \{1,2,3,4,5,6,8,10,12\}$ —— (1)

Taking R.H.S

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

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

$(A \cup B) \cup C = \{1,2,3,4,5,6,8\} \cup \{4,8,10,12\}$

$= \{1,2,3,4,5,6,8,10,12\}$ —— (2)

By (1) and (2)

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

(ii) Distributive property of union over intersection.

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

Taking L.H.S

$B \cap C = \{2,4,6,8\} \cap \{4,8,10,12\}$

$= \{4,8\}$

$A \cup (B \cap C) = \{1,2,3,4,5\} \cup \{4,8\}$

$= \{1,2,3,4,5,8\}$ —— (1)

Taking R.H.S

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

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

$A \cup C = \{1,2,3,4,5\} \cup \{4,8,10,12\}$

$A \cup C = \{1,2,3,4,5,8,10,12\}$

$(A \cup B) \cap (A \cup C) = \{1,2,3,4,5,6,8\} \cap \{1,2,3,4,5,8,10,12\}$

$= \{1,2,3,4,5,8\}$ —— (2)

By (1) and (2)

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

(iii) Distributive property of intersection over union.

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

Taking L.H.S

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

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

$A \cap (B \cup C) = \{1,2,3,4,5\} \cap \{2,4,6,8,10,12\}$

$= \{2,4\}$ —— (1)

Taking R.H.S

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

$A \cap B = \{2,4\}$

$A \cap C = \{1,2,3,4,5\} \cap \{4,8,10,12\}$

$= \{4\}$

$(A \cap B) \cup (A \cap C) = \{2,4\} \cup \{4\}$

$= \{2,4\}$ —— (2)

By (1) and (2)

$A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$ **Proved.**

(ii) $A = \{x | x \in z^+ \text{ and } x \leq 4\}$

$B = \{x | x \in z \text{ and } 0 < x < 5\}$

$C = \{1,2,3\}$

<u>Solution:</u> $A = \{1,2,3,4\}$

$B = \{1,2,3,4\}$; $C = \{1,2,3\}$

(i) **Associative property of union and of intersection.**

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

Taking L.H.S

$B \cup C = \{1,2,3,4\} \cup \{1,2,3\}$

$B \cup C = \{1,2,3,4\}$

$A \cup (B \cup C) = \{1,2,3,4\} \cup \{1,2,3,4\}$

$= \{1,2,3,4\}$ ——(1)

Taking R.H.S

$A \cup B = \{1,2,3,4\} \cup \{1,2,3,4\}$

$= \{1,2,3,4\}$

$(A \cup B) \cup C = \{1,2,3,4\} \cup \{1,2,3\}$

$= \{1,2,3,4\}$ ——(2)

By (1) and (2)

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

(ii) Distributive property of union over intersection.

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

Taking L.H.S

$B \cap C = \{1,2,3,4\} \cap \{1,2,3\}$

$= \{1,2,3\}$

$A \cup (B \cap C) = \{1,2,3,4\} \cup \{1,2,3\}$

$= \{1,2,3,4\}$ ——(1)

Taking R.H.S

$A \cup B = \{1,2,3,4\} \cup \{1,2,3,4\}$

$A \cup B = \{1,2,3,4\}$

$A \cup C = \{1,2,3,4\} \cup \{1,2,3\}$

$A \cup C = \{1,2,3,4\}$

$(A \cup B) \cap (A \cup C) = \{1,2,3,4\} \cap \{1,2,3,4\}$

$= \{1,2,3,4\}$ ——(2)

By (1) and (2)

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

(iii) Distributive property of intersection over union.

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

Taking L.H.S

$B \cup C = \{1,2,3,4\} \cup \{1,2,3\}$

$= \{1,2,3,4\}$

$A \cap (B \cup C) = \{1,2,3,4\} \cap \{1,2,3,4\}$

$= \{1,2,3,4\}$ ——(1)

Taking R.H.S

$A \cap B = \{1,2,3,4\} \cap \{1,2,3,4\}$

$= \{1,2,3,4\}$

$A \cap C = \{1,2,3,4\} \cap \{1,2,3\}$

$= \{1,2,3\}$

$(A \cap B) \cup (A \cap C) = \{1,2,3,4\} \cup \{1,2,3\}$

$= \{1,2,3,4\}$ ——(2)

By (1) and (2)

$A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$ **Proved.**

EXERCISE 1.3

Q1. If $A = \{a,b,c,d\}$ and $B = \{y,z\}$.

Find (i) $A\times B$ (ii) $B\times A$ (iii) $A\times A$ (iv) $B\times B$ Show that $A\times B \neq B\times A$ in general.

Solution:

(i) $A\times B = \{a,b,c,d\} \times \{y,z\}$

$= \{ (a,y), (a,z), (b,y), (b,z), (c,y), (c,z), (d,y), (d,z) \}$

Ans.

(ii) $B\times A = \{y,z\} \times \{a,b,c,d\}$

$= \{ (y,a), (y,b), (y,c), (y,d), (z,a), (z,b), (z,c), (z,d) \}$

Ans.

(iii) $A\times A = \{a,b,c,d\} \times \{a,b,c,d\}$

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

Ans.

(iv) $B\times B = \{y,z\} \times \{y,z\}$

$= \{ (y,y), (y,z), (z,y), (z,z) \}$ Ans.

Show that $A \times B \neq B \times A$ in general.

$$A \times B = \{a,b,c,d\} \times \{y,z\}$$
$$= \{(a,y),(a,z),(b,y),(b,z),(c,y),(c,z),(d,y),(d,z)\} \text{——(1)}$$
$$B \times A = \{y,z\} \times \{a,b,c,d\}$$
$$= \{(y,a),(y,b),(y,c),(y,d),(z,a),(z,b),(z,c),(z,d)\} \text{——(2)}$$

By (1) and (2)

$A \times B \neq B \times A$ **Proved.**

Q2. Suppose that the ordered pairs (x+y,2) and (4,x−y) are equal. Find x and y.

<u>Solution:</u> **given that**

$(x+y,2) = (4,x-y)$

on equating

on Adding
$$x + \cancel{y} = 4 \text{ ——(1)}$$
$$x - \cancel{y} = 2 \text{ ——(2)}$$

$$2x = 6$$

$$x = \frac{\cancel{6}^{3}}{\cancel{2}}$$

$\boxed{x = 3}$ Put the value of x in (1)

(1)⇒ $3 + y = 4$

$y = 4 - 3$

$\boxed{y = 1}$ **Ans.**

Q3. Let A = {a,b}, B = {2,3} and c = {3,4} find,

(i) A × (BUC)

<u>Solution:</u>

$BUC = \{2,3\} \cup \{3,4\}$

$BUC = \{2,3,4\}$

$A\times(BUC) = \{a,b\} \times \{2,3,4\}$

$= \{ (a,2), (a,3), (a,4), (b,2), (b,3), (b,4) \}$ **Ans.**

(ii) $\quad$ **$(A\times B) \cup (A\times C)$**

Solution:

$A\times B = \{a,b\} \times \{2,3\}$

$= \{ (a,2), (a,3), (b,2), (b,3) \}$

$A\times C = \{a,b\} \times \{3,4\}$

$= \{ (a,3), (a,4), (b,3), (b,4) \}$

$(A\times B) \cup (A\times C) = \{ (a,2), (a,3), (b,2), (b,3) \} \cup \{ (a,3), (a,4), (b,3), (b,4) \}$

$= \{ (a,2), (a,3), (a,4), (b,2), (b,3), (b,4) \}$ **Ans.**

(iii) $\quad$ $A\times(B\cap C)$

Solution:

$B\cap C = \{2,3\} \cap \{3,4\}$

$B\cap C = \{3\}$

$A\times(B\cap C) = \{a,b\} \times \{3\}$

$= \{ (a,3), (b,3)\}$ **Ans.**

(iv) $\quad$ **$(A\times B) \cap (A\times C)$**

Solution:

$A\times B = \{a,b\} \times \{2,3\}$

$= \{ (a,2), (a,3), (b,2), (b,3) \}$

$A\times C = \{a,b\} \times \{3,4\}$

$= \{ (a,3), (a,4), (b,3), (b,4) \}$

$(A\times B) \cap (A\times C) = \{ (a,2), (a,3), (b,2), (b,3) \} \cap \{ (a,3), (a,4), (b,3), (b,4) \}$

$(A\times B) \cap (A\times C) = \{ (a,3), (b,3) \}$ **Ans.**

Q4. For the sets given in Question # 3 find,

(i) $\quad$ **$A \times (B - C)$**

Solution:

$B - C = \{2,3\} - \{3,4\}$

$B - C = \{2\}$

$A\times(B-C) = \{a,b\} \times \{2\}$

$A\times(B-C) = \{ (a,2), (b,2) \}$ **Ans.**

(ii) $A \times (C - B)$

Solution:

$C - B = \{3,4\} - \{2,3\}$

$C - B = \{4\}$

$A \times (C - B) = \{a,b\} \times \{4\}$

$A \times (C - B) = \{(a,4), (b,4)\}$ **Ans.**

(iii) $A \times (B \cap C)$

Solution:

$B \cap C = \{2,3\} \cap \{3,4\}$

$B \cap C = \{3\}$

$A \times (B \cap C) = \{a,b\} \times \{3\}$

$= \{(a,3), (b,3)\}$ **Ans.**

(iv) $(A \times B) \cap (A \times C)$

Solution:

$A \times B = \{a,b\} \times \{2,3\}$

$= \{(a,2), (a,3), (b,2), (b,3)\}$

$A \times C = \{a,b\} \times \{3,4\}$

$= \{(a,3), (a,4), (b,3), (b,4)\}$

$(A \times B) \cap (A \times C) = \{(a,2), (a,3), (b,2), (b,3)\} \cap \{(a,3), (a,4),$
$(b,3), (b,4)\}$

$(A \times B) \cap (A \times C) = \{(a,3), (b,3)\}$ **Ans.**

Q5. Let $A = \{1,2,3,4\}$, $B = \{2,4,5,6\}$ and $C = \{2,3,6,8\}$. Find:

(i) $(A - B) \times (B - C)$

Solution:

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

$A - B = \{1,3\}$

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

$B - C = \{4,5\}$

$(A - B) \times (B - C) = \{1,3\} \times \{4,5\}$

$= \{(1,4), (1,5), (3,4), (3,5)\}$ **Ans.**

(ii) $\quad$ **$(A \cap B) \times (B \cap C)$**

Solution:

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

$A \cap B \quad = \quad \{2,4\}$

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

$B \cap C \quad = \quad \{2,6\}$

$(A \cap B) \times (B \cap C) = \{2,4\} \times \{2,6\}$

$= \{(2,2), (2,6), (4,2), (4,6)\}$ $\quad$ **Ans.**

(iii) $\quad$ **$(A \times B)) \cap (B \times C)$**

Solution:

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

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

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

$= \{(2,2), (2,3), (2,6), (2,8), (4,2), (4,3), (4,6), (4,8), (5,2), (5,3), (5,6), (5,8), (6,2), (6,3), (6,6), (6,8)\}$

$(A \times B) \cap (B \times C) = \{(1,2), (1,4), (1,5), (1,6), (2,2), (2,4), (2,5), (2,6), (3,2), (3,4), (3,5), (3,6), (4,2), (4,4), (4,5), (4,6)\}$
$\cap \{(2,2), (2,3), (2,6), (2,8), (4,2), (4,3), (4,6), (4,8), (5,2), (5,3), (5,6), (5,8), (6,2), (6,3), (6,6), (6,8)\}$

$(A \times B) \cap (B \times C) = \{(2,2), (2,6), (4,2), (4,6)\}$ $\quad$ **Ans.**

(iv) $\quad$ **$(A \times B) - (B \times C)$**

Solution:

$(A \times B) \quad = \quad \{1,2,3,4\} \times \{2,4,5,6\}$

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

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

$= \{(2,2), (2,3), (2,6), (2,8), (4,2), (4,3), (4,6), (4,8), (5,2), (5,3), (5,6), (5,8), (6,2), (6,3), (6,6), (6,8)\}$

$(A \times B) - (B \times C) = \{(1,2), (1,4), (1,5), (1,6), (2,2), (2,4), (2,5), (2,6), (3,2), (3,4), (3,5), (3,6), (4,2), (4,4), (4,5), (4,6)\} - \{(2,2), (2,3), (2,6), (2,8), (4,2),$

$(4,3), (4,6), (4,8), (5,2), (5,3), (5,6), (5,8),$
$(6,2), (6,3), (6,6), (6,8)\}$

$(A \times B) - (B \times C) = \{(1,2),(1,4), (1,5), (1,6), (2,4), (2,5),$
$(3,2), (3,4), (3,5), (3,6), (4,4), (4,5)\}$

Ans.

(v) **$(A \Delta B) \times (B \cap C)$**

Solution:

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

$A \Delta B = \{1,3,5,6\}$

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

$B \cap C = \{2,6\}$

$(A\Delta B)\times(B\cap C) = \{1,3,5,6\}\times\{2,6\}$

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

Ans.

(vi) **$(B\times C) \Delta (C\times A)$**

Solution:

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

$= \{(2,2), (2,3), (2,6), (2,8), (4,2),(4,3), (4,6), (4,8),$
$(5,2), (5,3), (5,6), (5,8), (6,2), (6,3), (6,6), (6,8) \}$

$C \times A = \{2,3,6,8\} \times \{1,2,3,4\}$

$= \{(2,1), (2,2), (2,3), (2,4), (3,1),(3,2), (3,3), (3,4),$
$(6,1), (6,2), (6,3), (6,4), (8,1), (8,2), (8,3), (8,4) \}$

$(B\times C) \Delta (C\times A) = \{(2,2), (2,3), (2,6), (2,8), (4,2),(4,3), (4,6),$
$(4,8), (5,2), (5,3), (5,6), (5,8), (6,2), (6,3),$
$(6,6), (6,8)\} \Delta \{ (2,1), (2,2), (2,3), (2,4),$
$(3,1),(3,2), (3,3), (3,4),(6,1), (6,2), (6,3), (6,4),$
$(8,1), (8,2), (8,3), (8,4) \}$

$(B\times A) \Delta (C\times A) = \{(2,6), (2,8), (4,2),(4,3), (4,6), (4,8), (5,2),$
$(5,3),(5,6), (5,8), (6,6), (6,8), (2,1), (2,4),$
$(3,1),(3,2),(3,3), (3,4), (6,1), (6,4), (8,1), (8,2),$
$(8,3),$

Q. 6: Let A = {a,b,c} and B = { x,y}. Write:

(i) Two relations in A×B.

Solution:

$A \times B = \{a,b,c\}\times\{x,y\}$

$A\times B = \{(a,x), (a,y), (b,x), (b,y), (c,x), (c,y)\}$

Two relations in A × B

$R_1 = \{\ \}$; $R_2 = \{(a,x)\}$ **Ans.**

(ii) To relations in B × A

Solution:

$B \times A = \{x, y\} \times \{a,b,c\}$

$= \{(x,a), (x,b), (x,c), (y,a), (y,b), (y,c)\}$

Two relations in B×A

$R_1 = \{\ \}$; $R_2 = \{(x,a)\}$ **Ans.**

(iii) Three relations in A.

Solution:

$A \times A = \{a,b,c\} \times \{a,b,c\}$

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

Three relations in A.

$R_1 = \{\ \}$; $R_2 = \{(a,a)\}$; $R_3 = \{(a,b)\}$ **Ans.**

(iv) All relations in B.

Solution:

$B \times B = \{x,y\} \times \{x,y\}$

$= \{(x,x), (x, y), (y,x), (y,y)\}$

All relations in B $2^4 = 16$

$R_1 = \{\ \}$ $R_9 = \{(x,y), (y,x)\}$

$R_2 = \{(x,x)\}$ $R_{10} = \{(x,y), (y,y)\}$

$R_3 = \{(x,y)\}$ $R_{11} = \{(y,x), (y,y)\}$

$R_4 = \{(y,x)\}$ $R_{12} = \{(x,x), (x,y), (y,x)\}$

$R_5 = \{(y,y)\}$ $R_{13} = \{(x,x), (x,y), (y,y)\}$

$R_6 = \{(x,x), \{x,y\}\}$ $R_{14} = \{(x,x), (x,y), (y,y)\}$

$R_7 = \{(x,x), (y,x)\}$ $R_{15} = \{(x,y), (y,x), (y,y)\}$

$R_8 = \{(x,x), (y,y)\}$ $R_{16} = \{(x,x),(x,y),(y,x),(y,y)\}$ Ans.

Q7. How many relations can $A \times B$ have, if set A has four elements and set B has three elements?

<u>Solution:</u>

$n(A) = 4 \quad ; \quad n(B) = 3$

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

$= 4\times3$

$= 12$

Number of relations in $A\times B = 12^{12} = 4096$ **Ans.**

Q8. List the ordered pairs in the relation R from $A = \{1,2,3,4\}$ to $B = \{0,1,2,3\}$ where $(a,b) \in R$ if and only if:

<u>Solution:</u>

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

$= \{(1,0), (1,1), (1,2), (1,3), (2,0), (2,1), (2,2), (2,3), (3,0), (3,1), (3,2), (3,3), (4,0), (4,1),(4,2), (4,3)\}$

(i) $\mathbf{a = b}$

(1,1) , (2,2), and (3,3) are be the required ordered pairs.

(ii) $\mathbf{a + b = 4}$

(1,3), (2,2), (3,1) and (4,0) are be the required ordered pairs.

(iii) $\mathbf{a > b}$

(1,0), (2,0), (2,1), (3,0), (3,1), (3,2), (4,0), (4,1), (4,2) and (4,3) are be the required ordered pairs.

(iv) a divides b

(1,1), (2,2), (3,3), (1,0), (2,0), (3,0), (4,0), (1,2), (1,3) and (4,2) are the required ordered pairs.

Q.9: If a, b represent elements of Z^+, the set of positive integers, find the domain and range of the relations in Z given by:

$R_1 = \{(a,b) \mid 2a + b = 10\}$

$R_2 = \{(a,b) \mid a+b = 8\}$

$R_3 = \{(a,b) \mid a-b = 8\}$

<u>Solution:</u>

As $Z = \{1,2,3,4,5,\ldots\ldots\}$

As $2a + b = 10$

For R_1:

$a = 1$ $\quad 2(1) + b = 10$ then $b = 8$

$a = 2$ $\quad 2(2) + b = 10$ then $b = 6$

$a = 3$ $\quad 2(3) + b = 10$ then $b = 4$

$a = 4$ $\quad 2(a) + b = 10$ $\quad b = 2$

Domain of $R_1 = \{1,2,3,4\}$ and

Range of $R_1 = \{8,6,4,2\}$

For R_2: $a + b = 8$

$a = 1$ $\quad 1 + b = 8$ $\quad b = 7$

$a = 2$ $\quad 2 + b = 8$ $\quad b = 6$

$a = 3$ $\quad 3 + b = 8$ $\quad b = 5$

$a = 4$ $\quad 4 + b = 8$ $\quad b = 4$

Domain of $R_2 = \{1,2,3,4\}$

Range of $R_2 = \{7,6,5,4\}$

For R_3: $\quad a - b = 8$

$a = 9$ $\quad 9 - b = 8$ $\quad b = 1$

$a = 10$ $\quad 10 - b = 8$ $\quad b = 2$

$a = 11$ $\quad 11 - b = 8$ $\quad b = 3$

$a = 12$ $\quad 12 - b = 8$ $\quad b = 4$

Dom of $R_3 = \{a > 8\}$ (or) $\{x | x \in N \wedge x \geq 9\}$

Range of $R_3 = N$ **Ans.**

Q10. The relations $R = \{(a,b) \mid b = 2a\}$ in Z, the set of integers, has the domain $\{-1,0,1,2\}$. Find its range.

Solution: $\quad$ **Domain $= \{-1,0,1,2\} = a$**

As $\quad b = 2a$

$b = 2(-1) = -2$

$b = 2(0) = 0$

$b = 2(1) = 2$

$b = 2(2) = 4$

Range of $R = \{-2,0,2,4\}$ **Ans.**

Q11. The relation $\{x,y) \mid y = x^2\}$ in the set Z has the domain Z^+. Find its range.

Solution:

Dom of $Z^+ = \{1,2,3,4,5,\ldots\ldots\} = x$

As $y = x^2$

$x = 1 \qquad y = (1)^2 = 1$

$x = 2 \qquad y = (2)^2 = 4$

$x = 3 \qquad y = (3)^2 = 9$

$x = 4 \qquad y = (4)^2 = 16$

Range $= \{1,4,9,16,\ldots\ldots\}$ **Ans.**

Q12. The set A = {1,2,3,4} has the following relations in it. Find whether these are function or not. If they are functions, find their types.

(1) R = {(1,2), (2,3), (3,4), (4,1)}

Solution: R_1 is a function from A onto A because:

(a) the entire set A is the domain of R_1.

(b) R_1 produces only one image in A for each member of the domain.

R_1 is also a one-one and onto function because distinct elements of 1st set A are associated with distinct elements of 2nd set A.

(2) R_2 = { (1,2), (3,4), (4,1) }

Solution: R_2 is not a function because the domain $R_2 \neq A$. The element 3 of set A is missing.

(3) R_3 = { (1,1), (1,2), (1,3), (1,4) }

Solution: R_3 is not a function. A relation in A is a function of A into A if and only if each element of A appears as the first element in one and only one ordered pair in the relation. Here 1 is repeated.

(4) R_4 = { (2,1), (4,4), (3,1), (2,3) }

Solution: R_4 is not a function as 2 is repeated as the first element.

Dom of $R_4 \neq$ A

Q13. List the 16 different relations on the set {0,1}. How many of the 16 different relations contains the pair (0,1)?

<u>Solution:</u> **If A = {0,1} then**

$A \times A = \{0,1\} \times \{0,1\}$

$= \{(0,0), (0,1), (1,0), (1,1)\}$

$R_1 = \{\ \}$

$R_2 = \{(0,0)\}$

$R_3 = \{(0,1)\}$

$R_4 = \{(1,0)\}$

$R_5 = \{(1,1)\}$

$R_6 = \{(0,0), (0,1)\}$

$R_7 = \{(0,0), (1,0)\}$

$R_8 = \{(0,0), (1,1)\}$

$R_9 = \{(0,1), (1,0)\}$

$R_{10} = \{(0,1), (1,1)\}$

$R_{11} = \{(0,0), (0,1), (1,0)\}$

$R_{12} = \{(0,0), (0,1), (1,1)\}$

$R_{13} = \{(0,1), (1,0), (1,1)\}$

$R_{14} = \{(0,0), (1,0), (1,1)\}$

$R_{15} = \{(1,0), (1,1)\}$

$R_{16} = \{(0,0), (0,1), (1,0), (1,1)\}$

There are 8 relations contains the point (0,1) **Ans.**

Q14. Let A = {1,2,3} and B = {1,2,3,4}. The relations R_1 = {(1,1), (2,2), (3,3)} and R_2 = {(1,1), (1,2), (1,3), (1,4)} are in A × B. Find:

(a) $R_1 \cup R_2$

<u>Solution:</u>

$R_1 \cup R_2 = \{(1,1), (2,2), (3,3)\} \cup \{(1,1), (1,2), (1,3), (1,4)\}$

$R_1 \cup R_2 = \{(1,1),(1,2),(1,3),(1,4),(2,2),(3,3)\}$ **Ans.**

(b) $R_1 \cap R_2$

<u>Solution:</u>

$R_1 \cap R_2 = \{(1,1), (2,2), (3,3)\} \cap \{(1,1), (1,2), (1,3), (1,4)\}$

$R_1 \cap R_2 = \{(1,1)\}$ **Ans.**

(c) $R_1 - R_2$

<u>Solution:</u>

$R_1 - R_2 = \{(1,1), (2,2), (3,3)\} - \{(1,1), (1,2), (1,3), (1,4)\}$

$R_1 - R_2 = \{(2,2), (3,3)\}$ **Ans.**

(d) $\mathbf{R_2 - R_1}$

Solution:

$R_2 - R_1 \;=\; \{(1,1), (1,2), (1,3), (1,4)\} - \{(1,1), (2,2), (3,3)\}$

$R_2 - R_1 \;=\; \{(1,2), (1,3), (1,4)\}$ **Ans.**

(e) $\mathbf{R_1 \Delta R_2}$

Solution:

$R_1 \Delta R_2 \;=\; \{ (1,1), (2,2), (3,3) \} \Delta \{ (1,1), (1,2), (1,3), (1,4)\}$

$R_1 \Delta R_2 \;=\; \{(1,2), (1,3), (1,4), (2,2), (3,3)\}$ **Ans.**

Q15. Let f = {(a,3), (b,2), (c,1), (d,3) } be a function from {a,b,c,d} to { 1,2,3}. Is f an onto function? Is f a one-one function?

Solution:

(1) Yes, f is an onto function because all the elements of Dom exist in f

(2) No, f is not a one-one function n (Dom) $\neq$ n (Range)

Q16. Let f = { (a,3), (b,2), (c,1), (d,3) } be a function from {a,b,c,d} to {1,2,3,4}. Is f one-one and onto?

Solution:

(1) No, f is not an onto function because Dom of f $\neq$ {1,2,3,4}

(2) No, f is not a one-one function because every elements of f does not hold distinct image.

Q.17: If A = { 1,2,3}, then find,

(i) A function f from A to A which is one-one.

Solution:

$A \times A \;=\; \{1,2,3\} \times \{1,2,3\}$

$\;=\; \{(1,1),(1,2),(1,3),(2,1),(2,2),(2,3),(3,1),(3,2),(3,3)\}$

then function is

$f \;=\; \{(1,1),(2,2), (3,3)\}$ **Ans.**

(ii) A function g from A to A which is onto.

Solution:

$A \times A \;=\; \{(1,1),(1,2),(1,3),(2,1),(2,2),(2,3),(3,1),(3,2),(3,3)\}$

then onto function g is

$g \;=\; \{(1,2),(2,1), (3,3)\}$ **Ans.**

(iii) A function h from A to A which is one-one and onto.

$A \times A = \{(1,1),(1,2),(1,3),(2,1),(2,2),(2,3),(3,1),(3,2),(3,3)\}$

then one-one and onto function h is.

$h = \{(1,3),(2,1),(3,2)\}$ **Ans.**

(iv) A function k from A to A which is neither one-one nor onto.

<u>Solution:</u>

$A \times A = \{(1,1),(1,2),(1,3),(2,1),(2,2),(2,3),(3,1),(3,2),(3,3)\}$

then a function k which is neither one-one nor onto is

$k = \{(1,1),(2,1),(3,2)\}$ **Ans.**

EXERCISE 1.4

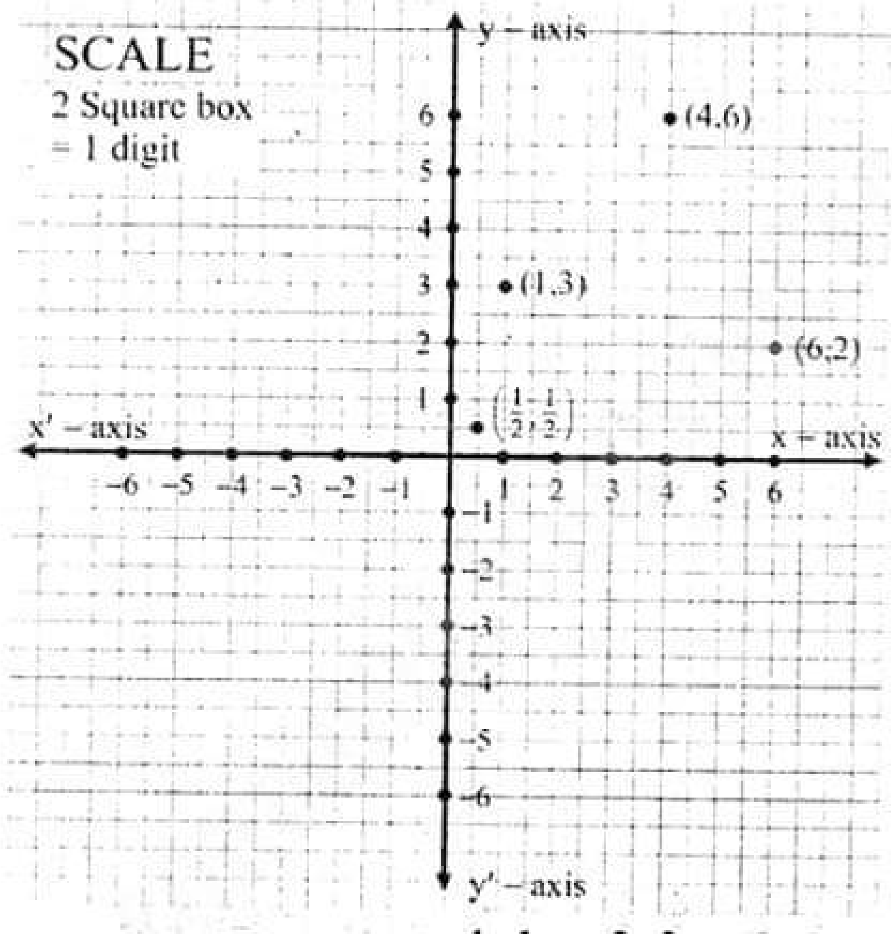
Q1. Write the quadrants in which the following points are located.

Solution:

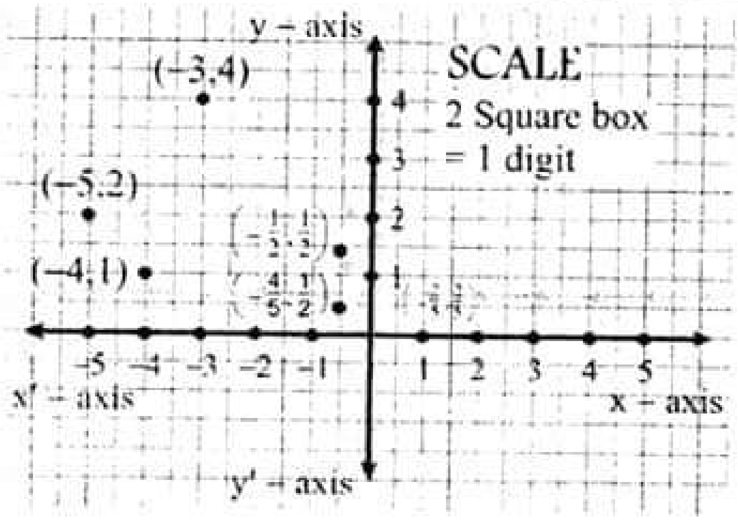
Points	Quadrant	Points	Quadrant
(1,6)	1st	(3, 57)	1st
$(\frac{1}{7}, \frac{4}{9})$	1st	$(\sqrt{5}, -6.54)$	4th
(−1.7 , 3)	2nd	(27, −72)	4^{th}
$(\sqrt{3}, -4)$	4th	(1.7, −2.7)	4th
$(\sqrt{2}, -\sqrt{3})$	4th	(−1, −11)	3rd
$(-7, \frac{-3}{2})$	3rd	$(\sqrt{3}, -1.3)$	4th
$(\frac{-\sqrt{3}}{2}, -1.7)$	3rd	$(\frac{7}{2}, \frac{1}{2})$	1st

Q2. Taking proper units, show the following points on a graph paper.

(i) $(4,6), (6,2), (\frac{1}{2}, \frac{1}{2}), (1,3)$



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



Q3. If $A = \{x \mid x \in N \text{ and } 2 \le x \le 5\}$ and
$B = \{x \mid x \in Z \text{ and } -6 < x < -3\}$
Find $A \times B$, $B \times A$ and $A \times A$.
Plot these sets on a graph paper.

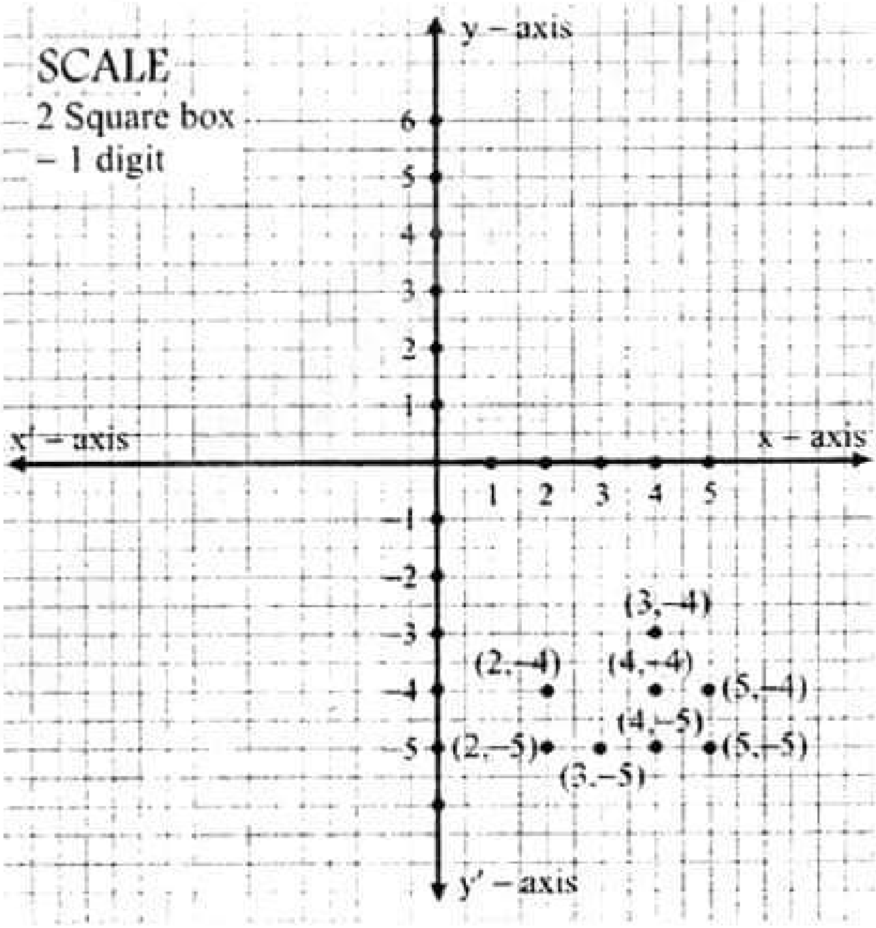
<u>Solution:</u>

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

$B = \{-5,-4\}$

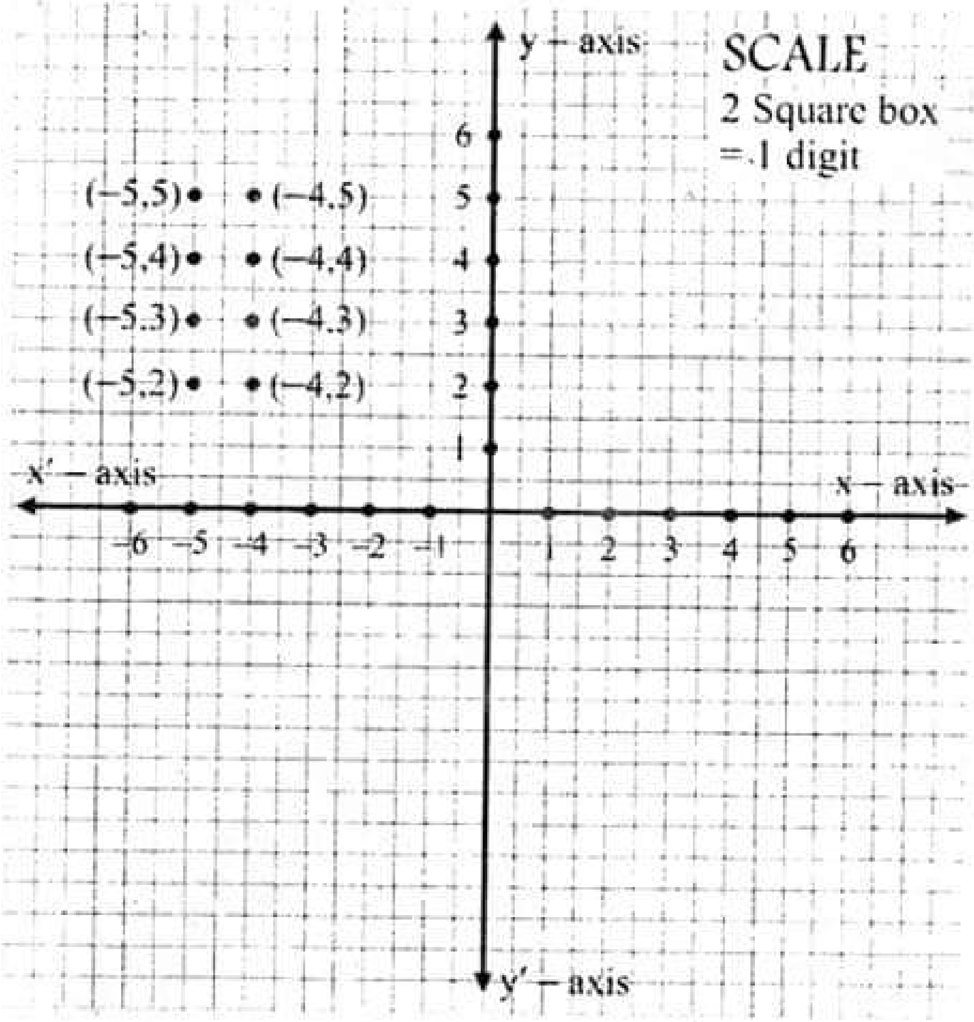
(i) $\mathbf{A \times B = \{2,3,4,5\} \times \{-4, -5\}}$

$= \{(2,-5), (2,-4), (3,-5), (3,-4), (4,-5), (4,-4), (5,-5), (5,-4)\}$



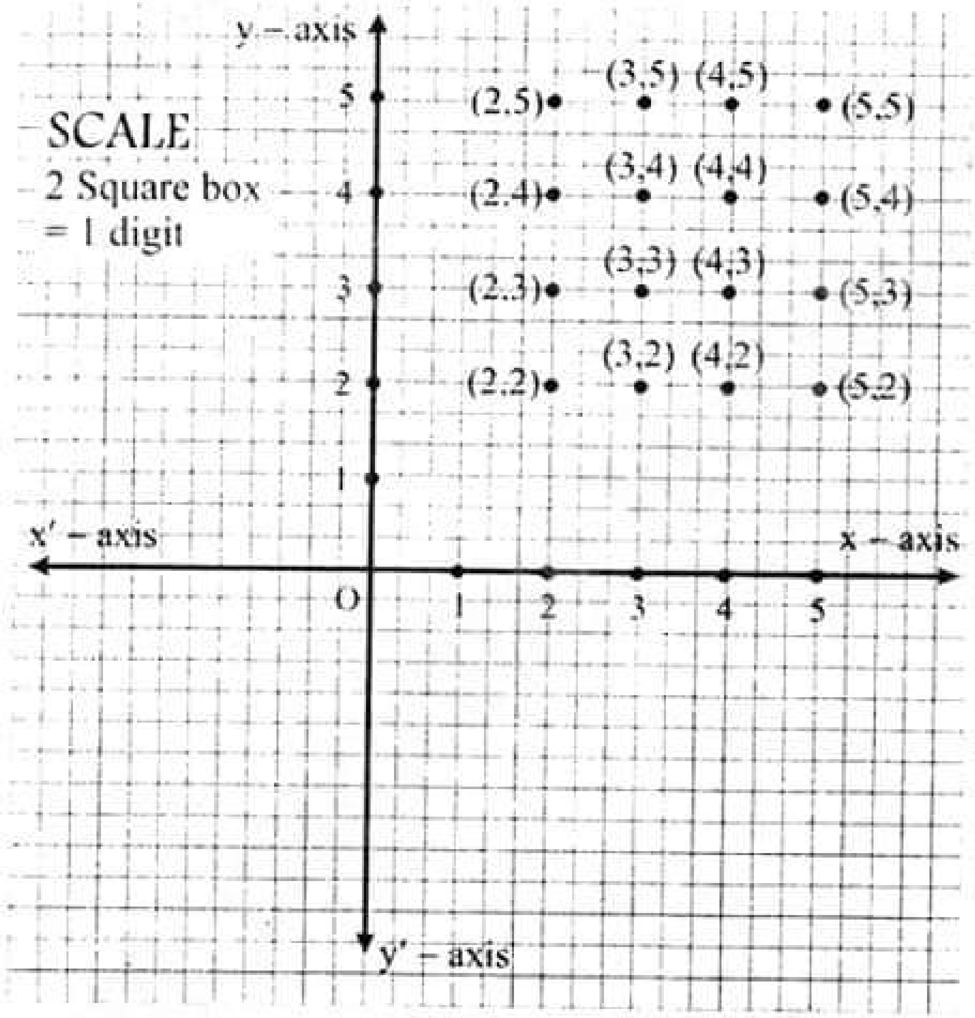
(ii) $B \times A = \{-5,-4\} \times \{2,3,4,5\}$

$= \{(-5,2), (-5,3), (-5,4), (-5,5), (-4,2), (-4,3), (-4,4), (-4,5)\}$



(iii) $\mathbf{A \times A = \{2,3,4,5\} \times \{2,3,4,5\}}$

$= \{(2,2), (2,3), (2,4), (2,5), (3,2), (3,3), (3,4), (3,5), (4,2), (4,3), (4,4), (4,5), (5,2), (5,3), (5,4), (5,5)\}$



Q4. Find the coordinates of the points A, B, C, D, E, F, G, H, plotted on the graph paper as shown below. What are the coordinates of the origin O?

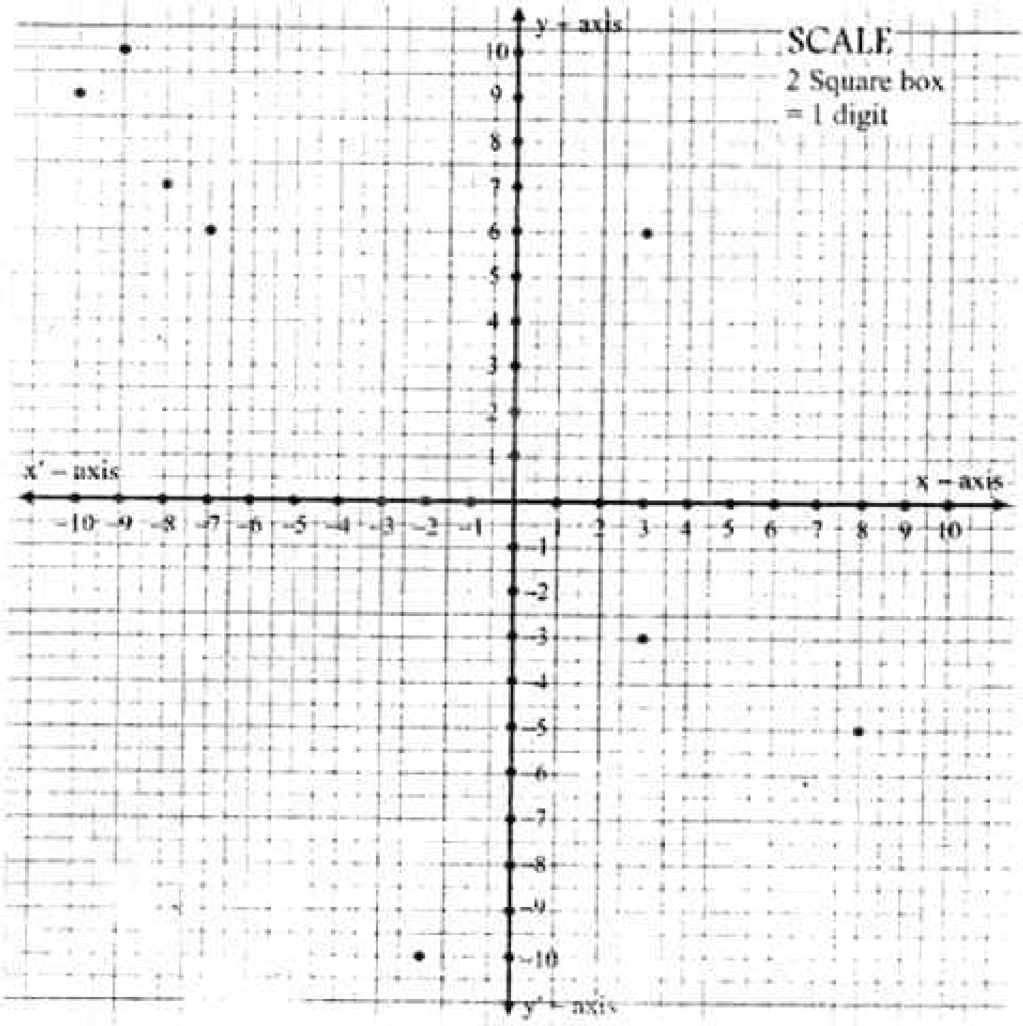
Solution:

The coordinates of the points A to H and O are taken as under:

A = (−9, 10) B = (−7, 6) C = (−8, 7) D = (3, −3)

E = (10, 9) F = (−2, −10) G = (3, 6) H = (8, −5)

O = (0, 0)



MISCELLANEOUS EXERCISE I

Q1. Write the following sets in tabular forms

(a) $\{x \mid x$ **is a rational number such that** $x^2 = 1\}$

Solution:

$A = \{-1, 1\}$ **Ans.**

because $x^2 = 1$

$x = \pm\sqrt{1} = \pm 1$

(b) $\{x \mid x$ **is a positive integer less than 12}**

Solution:

$B = \{1,2,3,4,5,6,7,8,9,10,11\}$ **Ans.**

Q2. Suppose that A = {2,4,6}, B= {2,6}. C = {4,6} and D = {4,6,8}. Determine which of these sets are the subsets of the other sets.

Solution: As $A = \{2,4,6\}$, $B = \{2,6\}$

$C = \{4,6\}$ and $D = \{4,6,8\}$

$\Rightarrow$ $B \subseteq A$, $C \subseteq A$, $C \subseteq D$ **Ans.**

Q3. Determine whether each of the following sets is the power set of a set.

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

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

Solution:

(a) No (b) Yes (c) No (d) Yes

Q4. Let A = {a,b,c,d} and B = {y,z}. Find

(a) $A \times B$

Solution:

$A \times B = \{a,b,c,d\} \times \{y,z\}$

$= \{(a,y),(a,z),(b,y),(b,z),(c,y),(c,z),(d,y),(d,z)\}$ **Ans.**

(b) $B \times A$

Solution:

$B \times A = \{y,z\} \times \{a,b,c,d\}$

$= \{(y,a),(y,b),(y,c),(y,d),(z,a),(z,b),(z,c),(z,d)\}$ **Ans.**

(c) **$A \times A$**

Solution:

$$A \times A = \{a,b,c,d\} \times \{a,b,c,d\}$$
$$= \{(a,a), (a,b), (a,c), (a,d), (b,a), (b,b), (b,c), (b,d), (c,a), (c,b), (c,c), (c,d), (d,a), (d,b), (d,c), (d,d)\}$$ **Ans.**

(d) **$B \times B$**

Solution:

$$B \times B = \{y,z\} \times \{y,z\}$$
$$= \{(y,y), (y,z), (z,y), (z,z)\}$$ **Ans.**

Q5. In which quadrant will a point lie on the coordinate plane whose coordinates are:

(i) **both positive?**

Solution: 1st quadrant

(ii) **both negative**

Solution: 3rd quadrant

Q6. (a) What will be the y-coordinate of a point which lies on *x*-aris ?

Solution: $y=0$ **Ans.**

(b) What will be the *x*-coordinate of a point which lies on y-aris?

Solution: $x=0$ **Ans.**

Q7. If $A = \{-1,1\}$ and $B = (\frac{1}{2}, \frac{1}{3}\}$ then write:

(a) **Two binary relations from A to B.**

Solution:

$$A \times B = \{-1,1\} \times (\frac{1}{2}, \frac{1}{3})$$

$$A \times B = \{(-1, \frac{1}{2}), (-1, \frac{1}{3}), (1, \frac{1}{2}), (1, \frac{1}{3})\}$$

Two binary relations from A to B

$R_1 = \{\ \}$, $R_2 = \{(-1, \frac{1}{2})\}$ **Ans.**

Unit # 1 Sets

(b) **Three binary relations from B to A**

Solution:

$B \times A = \{\frac{1}{2}, \frac{1}{3}\} \times \{-1, 1\}$

$= \{(\frac{1}{2}, -1), (\frac{1}{2}, 1), (\frac{1}{3}, -1), (\frac{1}{3}, -1)\}$

Two binary relations from A to B

$R_1 = \{\ \}$, $R_2 = \{(\frac{1}{2}, -1)\}$, $R_3 = \{(\frac{1}{2}, 1)\}$ **Ans.**

(c) **All the binary relations from A to A.**

Solution:

$A \times A = \{-1, 1\} \times \{-1, 1\}$

$= \{(-1, -1), (-1, 1), (1, -1), (1, 1)\}$

Total number of binary relations $= 2^n$

$= 2^4 = 16$

$R_1 = \{\ \}$

$R_2 = \{(-1, -1)\}$

$R_3 = \{(-1, 1)\}$

$R_4 = \{(1, 1)\}$

$R_5 = \{(1, -1)\}$

$R_6 = \{(-1, -1), (-1, 1)\}$

$R_7 = \{(-1, -1), (1, -1)\}$

$R_8 = \{(-1, -1), (1, 1)\}$

$R_9 = \{(-1, 1), (1, -1)\}$

$R_{10} = \{(-1, 1), (1, 1)\}$

$R_{11} = \{(1, -1), (1, 1)\}$

$R_{12} = \{(-1, -1), (-1, 1), (1, -1)\}$

$R_{13} = \{(-1, -1), (-1, 1), (1, 1)\}$

$R_{14} = \{(-1, -1), (1, -1), (1, 1)\}$

$R_{15} = \{(-1, 1), (1, -1), (1, 1)\}$

$R_{16} = \{(-1, -1), (-1, 1), (1, 1), (1, -1)\}$

(d) Four binary relations from B to B.

Solution:

$B \times B = \{\frac{1}{2}, \frac{1}{3}\} \times \{\frac{1}{2}, \frac{1}{3}\}$

$= \{(\frac{1}{2}, \frac{1}{2}), (\frac{1}{2}, \frac{1}{3}), (\frac{1}{3}, \frac{1}{2}), (\frac{1}{3}, \frac{1}{3})\}$

$R_1 = \{\ \}$, $R_2 = \{(\frac{1}{2}, \frac{1}{2})\}$, $R_3 = \{(\frac{1}{2}, \frac{1}{3})\}$, $R_4 = \{(\frac{1}{3}, \frac{1}{2})\}$ **Ans.**

Q8. If $S = \{1,2,3,4\}$ and $T = \{\frac{1}{2}, \frac{1}{4}, \frac{1}{6}, \frac{1}{8}\}$ then write:

(a) A one-one function from S to T.

Solution:

A one-one function from S to T is as under:

$f = \{(1, \frac{1}{2}), (2, \frac{1}{6}), (3, \frac{1}{4}), (4, \frac{1}{8})\}$ **Ans.**

(b) A function from S onto T

Solution:

A function from S onto T

$f = \{(1, \frac{1}{8}), (2, \frac{1}{4}), (3, \frac{1}{2}), (4, \frac{1}{6})\}$

(c) A function from S to T which is one-one and onto.

Solution:

A function from S to T which is one-one and onto

$f = \{(1, \frac{1}{4}), (2, \frac{1}{8}), (3, \frac{1}{2}), (4, \frac{1}{6})\}$ **Ans.**

(d) A function from S to T which is neither one-one r onto.

Solution:

A function from S to T which is neither one-one onto.

$f = \{(1, \frac{1}{2}), (2, \frac{1}{2}), (3, \frac{1}{4}), (4, \frac{1}{4}\}$ **Ans.**

Q.9 If U = { x | x is a letter in the English alphabet.

A = {a,b,c,d,e,f}, B = {a,e,i,o,u} and C = {u,v,w,x,y,z}, list the elements of:

(a) A ∩ (B ∩ C) (b) A ∩ (BUC) (c) (A∩B) U (A∩C)
(d) A U (BUC)′ (e) A ∩ B ∩ C′ (f) (A U B)′ U C

Illustrate each set by means of a Venn diagram.

Solution: (a) A ∩ (B ∩ C)

B ∩ C = {a,e,i,o,u} ∩ {u,v,w,x,y,z})

B ∩ C = {u}

A∩(B∩C)= {a,b,c,d,e,f } ∩ {u}

A∩(B∩C)= { } **Ans.**

(b) **A ∩ (BUC)**

Solution:

BUC = {a,e,i,o,u} U {u,v,w,x,y,z}

BUC = {a,e,i,o,u,v,w,x,y,z}

A∩(BUC)= {a,b,c,d,e,f} ∩ {a,e,i,o,u,v,w,x,y,z}

A∩(BUC)= {a,e} **Ans.**

(c) **(A∩B) U (A∩C)**

Solution:

A∩B = {a,b,c,d,e,f} ∩ {a,e,i,o,u}

A∩B = {a,e}

A∩C = {a,b,c,d,e,f} ∩ {u,v,w,x,y,z}

A∩C = { }

(A∩B) U (A∩C) = {a,e} U { }

(A∩B) U (A∩C) = {a,e} **Ans.**

(d) **A ∩ (BUC)′**

Solution:

BUC = {a,e,i,o,u} U {u,v,w,x,y,z}

BUC = {a,e,i,o,u,v,w,x,y,z}

U − BUC= {a,b,c,d,……,z} − {a,e,i,o,u,v,w,x,y,z}

(BUC)′ = {b,c,d,f,g,h,i,j,k,ℓ,m,n,p,q,r,s,t}

A∩(BUC)′= {a,b,c,d,e,f} ∩ {b,c,d,f,g,h,i,j,k,ℓ,m,n,p,q,r,s,t}

$A\cap(B\cup C)' = \{b,c,e,f\}$ **Ans.**

(e) $\mathbf{A \cap B \cap C'}$

<u>Solution:</u>

$U - C = \{a,b,c,d,\ldots\ldots,z\} - \{u,v,w,x,y,z\}$

$C' = \{a,b,c,d,e,f,g,h,\ldots\ldots,r,s,t\}$

$A\cap B = \{a,b,c,d,e,f\} \cap \{a,e,i,o,u\}$

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

$A\cap B\cap C' = \{a,e\} \cap \{a,b,c,d,\ldots\ldots,r,s,t\}$

$A\cap B\cap C' = \{a,e\}$ **Ans.**

(f) $\mathbf{(A\cup B)' \cup C}$

<u>Solution:</u>

$A\cup B = \{a,b,c,d,e,f\} \cup \{a,e,i,o,u\}$

$A\cup B = \{a,b,c,d,e,f,i,o,u\}$

$U-(A\cup B) = \{a,b,c,d,\ldots\ldots,z\} - \{a,b,c,d,e,f,i,o,u\}$

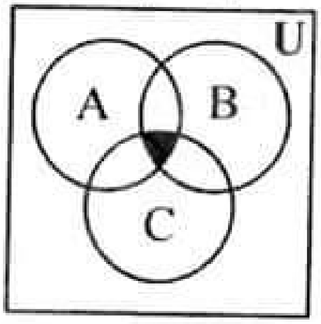
$(A\cup B)' = \{g,h,j,k,\ell,m,n,p,q,r,s,t,v,w,x,y,z\}$

$(A\cup B)' \cup C = \{g,h,j,k,\ell,m,n,p,q,r,s,t,v,w,x,y,z\} \cup \{u,v,w,x,y,z\}$

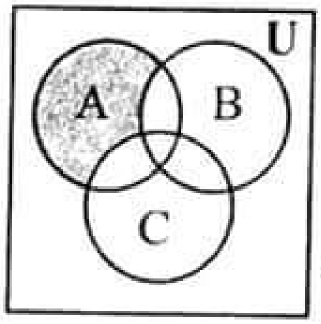
$(A\cup B)' \cup C = \{g,h,j,k,\ell,m,n,p,q,r,s,t,u,v,w,x,y,z\}$ **Ans.**

Illustration by Venn Diagrams:

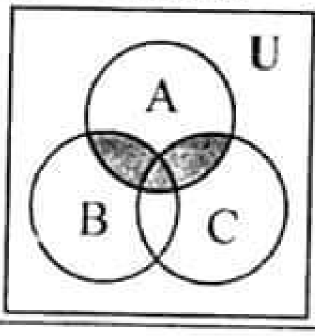
Q9(a). $\mathbf{A\cap(B\cap C)}$



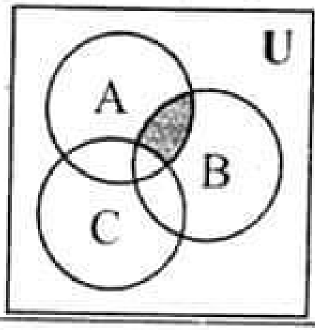
Q9(d). $\mathbf{A \cap (B \cap C)'}$



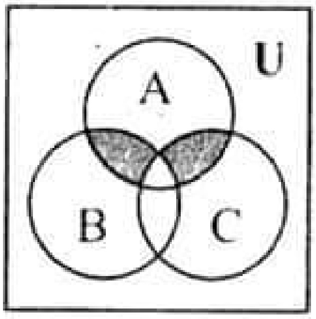
Q9(b). $\mathbf{A\cap(B\cup C)}$



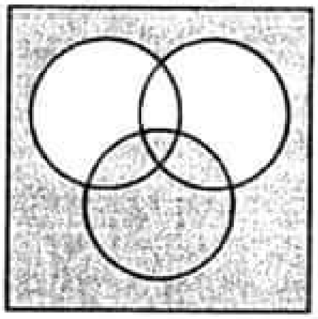
Q9(e). $\mathbf{(A\cap B) \cap C'}$



Q9(c). $(A \cap B) \cup (A \cap C)$



Q9(f). $(A \cup B)' \cup C$



Q10. **Which of the following statements are true and which of them are false?**

(i) **If $A = \{x,y\}$ and $B = \{y,z,t\}$, then $A \subseteq B$**

Solution: False **Ans.**

(ii) **If $A = \{1,2,3\}$ and $U = N$, then $A \cup A = N$**

Solution: False **Ans.**

(iii) **The set $A = \{ 1, \frac{1}{10}, \frac{1}{100}, \ldots\ldots, \frac{1}{10^{20}} \}$ is an infinite set.**

Solution: False **Ans.**

(iv) **The intersection of two disjoint sets is empty.**

Solution: True **Ans.**

(v) **The set of natural numbers between 40 and 42 is the empty set.**

Solution: False **Ans.**

(vi) **$A \cup B = AB$**

Solution: False **Ans.**

(vii) **$A \times B = B \times A$**

Solution: False **Ans.**

(viii) **$(2,-3) = (-3,2)$**

Solution: False **Ans.**

(ix) **$\varnothing = \{ \varnothing \}$**

Solution: False **Ans.**

(x) **If A contains m elements and B contains n elements, then $A \times B$ contains mn ordered pairs.**

Solution: True **Ans.**

Q11. Complete the sentences.

(i) $A \cap (BUC) = \underline{(A \cap B) \cup (A \cap C)}$

(ii) $A \Delta B = \underline{\{x | x \in A \text{ or } x \in B \text{ but } \notin A \cap B}$.

(iii) $(a,b) \underline{\neq} (b,a)$

(iv) $(AUB)' = \underline{A' \cap B'}$

(v) If $(x + 2, 3y - 6) = (2x, y)$ then $x = \underline{2} = y = \underline{3}$

(vi) If f is one-one onto function from A to B, then $n(A) \underline{=} n(B)$.

(vii) $(-3,-2)$ is in **Third** quadrant.

(viii) $A = \{2,4,8\}$ and $B = \{2^1, 2^2, 2^3\}$ are **equal** sets.

(ix) Corresponding to any **point** in a plane there is an ordered pair of real numbers.

(x) If $R = \{(1,2), (2,3), (3,4)\}$ then Dom $R = \underline{\{1,2,3\}}$ and Range $R = \underline{\{2,3,4\}}$.

Q12. Select the correct answer and write it in the blank space.

(i) The Cartesian product of sets A and B is written as **A×B**.

(a) A . B (b) A × B (c) A Δ B (d) B × A

(ii) $\{2,4,6,8, \ldots, 50\}$ written in set builder form $\underline{\{x | x \in R \; 2 \le x \le 50\}}$

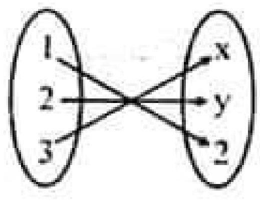
(a) $\{x | x \in N, x \le 50\}$ (b) $\{x | x \in E, x \le 50\}$

(c) $\{x | x \in E, x \le x \le 50\}$ (d) $\{x | x \in Q, x \le 50\}$

(iii) {0,1,2,3, ...} is the set of whole numbers.

(a) prime numbers (b) integers

(c) whole numbers (d) even numbers

(iv) 

Represent one to one and onto function.