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NCERT Class 11 Mathematics Solutions: Chapter 1 – Sets Miscellaneous Exercise Part 5

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Set operations: Intersection

- Formal definition for the intersection of two sets:

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

- Examples

- $\{1, 2, 3\} \cap \{3, 4, 5\} = \{3\}$
- $\{a, b\} \cap \{3, 4\} = \emptyset$
- $\{1, 2\} \cap \emptyset = \emptyset$

- Properties of the intersection operation

- | | |
|---|-----------------|
| ▪ $A \cap U = A$ | Identity law |
| ▪ $A \cap \emptyset = \emptyset$ | Domination law |
| ▪ $A \cap A = A$ | Idempotent law |
| ▪ $A \cap B = B \cap A$ | Commutative law |
| ▪ $A \cap (B \cap C) = (A \cap B) \cap C$ | Associative law |

1. Show that $A \cap B = A \cap C$ need not imply $B = C$.

Answer:

Consider, $A = \{0, 1\}$, $B = \{0, 2, 3\}$ and $C = \{0, 4, 5\}$

Accordingly, $A \cap B = \{0\}$ and $A \cap C = \{0\}$

Here, $A \cap B = A \cap C = \{0\}$

However, $B \neq C$ [$2 \in B$ and $2 \notin C$]

2. Let A and B be sets. If $A \cap X = B \cap X = \varnothing$ and $A \cup X = B \cup X$ for some set X , show that $A = B$.

(Hints $A = A \cap (A \cup X)$, $B = B \cap (B \cup X)$ and use distributive law)

Answer:

Consider A and B be two sets such that $A \cap X = B \cap X = \varnothing$ and $A \cup X = B \cup X$ for some set X to show $A = B$.

It can be seen that

$$\begin{aligned} A &= A \cap (A \cup X) = A \cap (B \cup X) [\because A \cup X = B \cup X] \\ &= (A \cap B) \cup (A \cap X) \text{ [Distributive law]} \\ &= (A \cap B) \cup \varnothing [\because A \cap X = \varnothing] \\ &= A \cap B \dots \text{eq (1)} \end{aligned}$$

Now, $B = B \cap (B \cup X)$

$$\begin{aligned} &= B \cap (A \cup X) [\because A \cup X = B \cup X] \\ &= (B \cap A) \cup (B \cap X) \text{ [Distributive law]} \\ &= (B \cap A) \cup \varnothing [\because B \cap X = \varnothing] \\ &= B \cap A \\ &= A \cap B \dots \text{eq (2)} \end{aligned}$$

Hence, from (1) and (2), we obtain $A = B$.

2. Find sets A , B and C such that $A \cap B$, $B \cap C$ and $A \cap C$ are non-empty sets and $A \cap B \cap C = \varnothing$.

Answer:

Consider $A = \{0, 1\}$, $B = \{1, 2\}$, and $C = \{2, 0\}$.

Accordingly, $A \cap B = \{1\}$, $B \cap C = \{2\}$, and $A \cap C = \{0\}$.

$\therefore A \cap B$, $B \cap C$, and $A \cap C$ are non-empty.

However, $A \cap B \cap C = \varnothing$

3. In a survey of 600 students in a school, 150 students were found to be taking tea and 225 taking coffee, 100 were taking both tea and coffee. Find how many students were taking neither tea nor coffee.

Answer:

Consider U be the set of all students who took part in the survey.

Consider T be the set of students taking tea.

Consider U be the set of students taking coffee.

Accordingly, $n(U) = 600, n(T) = 150, n(C) = 225, n(T \cap C) = 100$

To find: Number of student taking neither tea nor coffee i.e.,

We have to find $n(T' \cap C')$.

$$\begin{aligned}n(T' \cap C') &= n(T \cup C)' \\&= n(U) - n(T \cup C) \\&= n(U) - [n(T) + n(C) - n(T \cap C)] \\&= 600 - [150 + 225 - 100] \\&= 600 - 275 \\&= 325\end{aligned}$$

Hence, 325 students were taking neither tea nor coffee.