

# NCERT Solutions Class 12 Maths

## Chapter 1: Relations and Functions

### EXERCISE 1.1

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**Quick Summary:** In NCERT Solutions Class 12 Maths Chapter 1 Exercise 1.1, students learn about different types of relations including reflexive, symmetric, transitive, and equivalence relations. This exercise covers fundamental properties of relations on sets and their practical applications, which form the foundation for advanced topics in discrete mathematics and are frequently tested in CBSE board exams and competitive exams like JEE.

#### Key Takeaways:

- A relation  $R$  on set  $A$  is reflexive if  $(a,a) \in R$  for all  $a \in A$
- A relation is symmetric if  $(a,b) \in R$  implies  $(b,a) \in R$ , and transitive if  $(a,b) \in R$  and  $(b,c) \in R$  implies  $(a,c) \in R$
- An equivalence relation must satisfy all three properties: reflexive, symmetric, and transitive
- Understanding relation types is crucial for solving problems involving functions, mappings, and set theory in higher mathematics

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## Question 1

### QUESTION

Determine whether each of the following relations are reflexive, symmetric and transitive:

1. Relation  $R$  in the set  $A = \{1, 2, 3, \dots, 13, 14\}$  defined as  $R = \{(x, y) : 3x - y = 0\}$ .
2. Relation  $R$  in the set  $\mathbb{N}$  of natural numbers defined as  $R = \{(x, y) : y = x + 5 \text{ and } x < 4\}$ .
3. Relation  $R$  in the set  $A = \{1, 2, 3, 4, 5, 6\}$  given by  $R = \{(x, y) : y \text{ is divisible by } x\}$ .
4. Relation  $R$  in the set  $\mathbb{Z}$  of all integers defined as  $R = \{(x, y) : x - y \text{ is an integer}\}$ .
5. Relation  $R$  in the set  $A$  of human beings in a town at a particular time given by:
  1.  $R = \{(x, y) : x \text{ and } y \text{ work at the same place}\}$
  2.  $R = \{(x, y) : x \text{ and } y \text{ live in the same locality}\}$
  3.  $R = \{(x, y) : x \text{ is exactly } 7 \text{ cm taller than } y\}$
  4.  $R = \{(x, y) : x \text{ is wife of } y\}$
  5.  $R = \{(x, y) : x \text{ is father of } y\}$

### SOLUTION

This question tests our understanding of reflexive, symmetric, and transitive relations. We need to analyze each given relation and determine which properties it satisfies.

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(i) in

#### Step 1: Check for reflexivity

For to be reflexive, for all . This means must be true, or , which implies . But . Also, for , . Thus, is not reflexive.

#### Step 2: Check for symmetry

If , then must also be in . Let's take , then . So, . Now, we need to check if . For to be in , must be true, which simplifies to , which is false. Thus, is not symmetric.

#### Step 3: Check for transitivity

If and , then must be in . Let's take , then . So, . Now, let's find a such that . This means , so . Thus, . Now, we need to check if . For to be in , must be true, which simplifies to , which is false. Thus, is not transitive.

**Final Answer:** Neither reflexive nor symmetric nor transitive.

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(ii) in

#### Step 1: List the elements of $R$

Since and , the possible values for are 1, 2, and 3. Then, the corresponding values for are , , and . So, .

#### Step 2: Check for reflexivity

For to be reflexive, for all . However, , , and are not in . Thus, is not reflexive.

**Step 3: Check for symmetry**

For to be symmetric, if , then must also be in . Since , we need to check if . However, , so . Thus, is not symmetric.

**Step 4: Check for transitivity**

For to be transitive, if and , then must be in . We have . There are no pairs and in , so the condition is vacuously true. Therefore, is transitive.

**Final Answer:** Neither reflexive nor symmetric but transitive.

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(iii) in

**Step 1: Check for reflexivity**

For to be reflexive, for all . Since every number is divisible by itself, is divisible by for all . Thus, is reflexive.

**Step 2: Check for symmetry**

For to be symmetric, if , then must also be in . Let's take and . Since 2 is divisible by 1, . However, 1 is not divisible by 2, so . Thus, is not symmetric.

**Step 3: Check for transitivity**

For to be transitive, if and , then must be in . If is divisible by and is divisible by , then must be divisible by . For example, let , , and . Then and , and since 4 is divisible by 1. Thus, is transitive.

**Final Answer:** Reflexive and transitive but not symmetric.

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(iv) in

**Step 1: Check for reflexivity**

For to be reflexive, for all . Since , and 0 is an integer, for all . Thus, is reflexive.

**Step 2: Check for symmetry**

For to be symmetric, if , then must also be in . If is an integer, then is also an integer. Thus, is symmetric.

**Step 3: Check for transitivity**

For to be transitive, if and , then must be in . If is an integer and is an integer, then is also an integer. Thus, is transitive.

**Final Answer:** Reflexive, symmetric and transitive.

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(v)(a) in (set of human beings)

**Step 1: Check for reflexivity**

Every person works at the same place as themselves. Thus, , and is reflexive.

**Step 2: Check for symmetry**

If and work at the same place, then and work at the same place. Thus, if , then , and is symmetric.

**Step 3: Check for transitivity**

If and work at the same place, and and work at the same place, then and work at the same place. Thus, if and , then , and is transitive.

**Final Answer:** Reflexive, symmetric and transitive.

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(v)(b) in (set of human beings)

**Step 1: Check for reflexivity**

Every person lives in the same locality as themselves. Thus, , and is reflexive.

**Step 2: Check for symmetry**

If and live in the same locality, then and live in the same locality. Thus, if , then , and is symmetric.

**Step 3: Check for transitivity**

If and live in the same locality, and and live in the same locality, then and live in the same locality. Thus, if and , then , and is transitive.

**Final Answer:** Reflexive, symmetric and transitive.

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(v)(c) in (set of human beings)

**Step 1: Check for reflexivity**

A person cannot be 7 cm taller than themselves. Thus, , and is not reflexive.

**Step 2: Check for symmetry**

If is 7 cm taller than , then is 7 cm shorter than , not taller. Thus, if , then , and is not symmetric.

**Step 3: Check for transitivity**

If is 7 cm taller than , and is 7 cm taller than , then is 14 cm taller than , not 7 cm. Thus, if and , then , and is not transitive.

**Final Answer:** Neither reflexive nor symmetric nor transitive.

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(v)(d) in (set of human beings)

**Step 1: Check for reflexivity**

A person cannot be the wife of themselves. Thus, , and is not reflexive.

**Step 2: Check for symmetry**

If is the wife of , then is the husband of , not the wife. Thus, if , then , and is not symmetric.

**Step 3: Check for transitivity**

If is the wife of , and is the wife of is impossible in normal situations. However, if we consider the case where is empty, then is transitive.

**Final Answer:** Neither reflexive nor symmetric but transitive.

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(v)(e) in (set of human beings)

**Step 1: Check for reflexivity**

A person cannot be the father of themselves. Thus, , and is not reflexive.

**Step 2: Check for symmetry**

If is the father of , then is the child of , not the father. Thus, if , then , and is not symmetric.

**Step 3: Check for transitivity**

If is the father of , and is the father of , then is the grandfather of , not the father. Thus, if and , then , and is not transitive.

**Final Answer:** Neither reflexive nor symmetric nor transitive.

**ANSWER**

- (i) Neither reflexive nor symmetric nor transitive.
- (ii) Neither reflexive nor symmetric but transitive.
- (iii) Reflexive and transitive but not symmetric.
- (iv) Reflexive, symmetric and transitive.
- (v)(a) Reflexive, symmetric and transitive.
- (v)(b) Reflexive, symmetric and transitive.
- (v)(c) Neither reflexive nor symmetric nor transitive.
- (v)(d) Neither reflexive nor symmetric but transitive.
- (v)(e) Neither reflexive nor symmetric nor transitive.

## Question 2

### QUESTION

Show that the relation  $R$  in the set  $\mathbb{R}$  of real numbers, defined as  $R = \{(a,b) : a \leq b^2\}$ , is neither reflexive nor symmetric nor transitive.

### SOLUTION

We are given a relation on the set of real numbers defined as  $R = \{(a,b) : a \leq b^2\}$ . We need to show that this relation is neither reflexive, nor symmetric, nor transitive.

#### Step 1: Check for Reflexivity

For  $R$  to be reflexive, we need for all  $a \in \mathbb{R}$ ,  $(a,a) \in R$ . This means for all real numbers  $a$ ,  $a \leq a^2$ . However, this is not true for all real numbers. For example, consider  $a = -1$ . Then  $(-1,-1) \notin R$ . Since  $(-1,-1) \notin R$ , the relation is not reflexive.

#### Step 2: Check for Symmetry

For  $R$  to be symmetric, if  $(a,b) \in R$ , then  $(b,a) \in R$  must also hold. In other words, if  $a \leq b^2$ , then  $b \leq a^2$  must be true. Let's take  $a = 1$  and  $b = 1$ . We have  $(1,1) \in R$  since  $1 \leq 1^2$ . However,  $(1,1) \in R$  means  $1 \leq 1^2$ , which is true. Now, let's take  $a = 1$  and  $b = -1$ . We have  $(1,-1) \in R$  since  $1 \leq (-1)^2$ . However,  $(-1,1) \notin R$  since  $-1 \not\leq 1^2$ , which is true. Let's consider  $a = 1$  and  $b = 2$ . Then  $(1,2) \in R$  since  $1 \leq 2^2$ . However,  $(2,1) \notin R$  since  $2 \not\leq 1^2$ , which is true. Let's try  $a = 1$  and  $b = -2$ . Then  $(1,-2) \in R$  since  $1 \leq (-2)^2$ , which is true. However,  $(-2,1) \notin R$  since  $-2 \not\leq 1^2$ , which is false. Therefore, the relation is not symmetric.

#### Step 3: Check for Transitivity

For  $R$  to be transitive, if  $(a,b) \in R$  and  $(b,c) \in R$ , then  $(a,c) \in R$  must hold. That is, if  $a \leq b^2$  and  $b \leq c^2$ , then  $a \leq c^2$  must be true. Let's take  $a = 1$ ,  $b = 1$ , and  $c = 1$ . We have  $(1,1) \in R$  since  $1 \leq 1^2$ , and  $(1,1) \in R$  since  $1 \leq 1^2$ . However,  $(1,1) \in R$  means  $1 \leq 1^2$ , which is false. Therefore, the relation is not transitive.

#### Conclusion:

Since the relation is neither reflexive, nor symmetric, nor transitive, we have shown that  $R = \{(a,b) : a \leq b^2\}$  is neither reflexive nor symmetric nor transitive.

### ANSWER

The relation  $R = \{(a,b) : a \leq b^2\}$  is neither reflexive nor symmetric nor transitive.

### Question 3

#### QUESTION

Check whether the relation  $R$  defined in the set  $\{1,2,3,4,5,6\}$  as  $R = \{(a,b) : b = a + 1\}$  is reflexive, symmetric or transitive.

#### SOLUTION

We are given a relation defined on the set  $S$ . We need to check if this relation is reflexive, symmetric, or transitive.

##### Step 1: Check for reflexivity

For a relation to be reflexive,  $(a,a)$  must be in  $R$  for all  $a$  in  $S$ . In other words,  $b = a + 1$  must be true for all  $a$  in  $S$ . This is clearly false.

For example,  $(1,1)$  should be in  $R$ , but since  $1 \neq 1 + 1$ ,  $(1,1)$  is not in  $R$ . Therefore,  $R$  is not reflexive.

##### Step 2: Check for symmetry

For a relation to be symmetric, if  $(a,b)$  is in  $R$ , then  $(b,a)$  must also be in  $R$ . Let's consider an example. We have  $(1,2)$  in  $R$  because  $2 = 1 + 1$ . For  $(2,1)$  to be symmetric,  $(2,1)$  must also be in  $R$ . However,  $1 \neq 2 + 1$ , so  $(2,1)$  is not in  $R$ . Therefore,  $R$  is not symmetric.

##### Step 3: Check for transitivity

For a relation to be transitive, if  $(a,b)$  and  $(b,c)$  are in  $R$ , then  $(a,c)$  must also be in  $R$ . Let's consider  $(1,2)$  and  $(2,3)$ . Since  $(1,2)$  and  $(2,3)$  are in  $R$ , for  $R$  to be transitive,  $(1,3)$  must also be in  $R$ . However,  $3 \neq 1 + 1$ , so  $(1,3)$  is not in  $R$ . Therefore,  $R$  is not transitive.

**Final Answer:** The relation is neither reflexive, nor symmetric, nor transitive.

#### ANSWER

Neither reflexive nor symmetric nor transitive.

## Question 4

### QUESTION

Show that the relation  $R$  in  $\mathbb{R}$  defined as  $R = \{(a,b) : a \leq b\}$  is reflexive and transitive but not symmetric.

### SOLUTION

We need to prove that the relation defined on the set of real numbers is reflexive and transitive, but not symmetric.

#### Step 1: Check for Reflexivity

For a relation to be reflexive, must belong to for all . Since is always true for any real number , we have for all . Therefore, is reflexive.

#### Step 2: Check for Symmetry

For a relation to be symmetric, if , then must also belong to . Let's consider an example. If and , then because . However, because . Therefore, is not symmetric.

#### Step 3: Check for Transitivity

For a relation to be transitive, if and , then must also belong to . In other words, if and , then we must have . This is a fundamental property of real numbers. If and , then it is always true that . Therefore, , and is transitive.

#### Conclusion:

The relation is reflexive and transitive but not symmetric, as demonstrated above.

### ANSWER

The relation  $R = \{(a,b) : a \leq b\}$  is reflexive and transitive but not symmetric.

## Question 5

### QUESTION

Check whether the relation  $R$  in  $\mathbb{R}$  defined by  $R = \{(a,b) : a \leq b^3\}$  is reflexive, symmetric or transitive.

### SOLUTION

We are given a relation defined on the set of real numbers as  $R$ . We need to check if this relation is reflexive, symmetric, or transitive.

#### Step 1: Check for Reflexivity

A relation is reflexive if for all  $a \in \mathbb{R}$ . In other words, we need to check if for all real numbers  $a$ ,  $(a,a) \in R$ .

Consider  $a = 1$ . Then  $(1,1) \in R$ .

Since  $(1,1) \notin R$ , the relation is not reflexive.

#### Step 2: Check for Symmetry

A relation is symmetric if whenever  $(a,b) \in R$ , then  $(b,a) \in R$ . In other words, if  $a \leq b^3$ , then  $b \leq a^3$  must also be true.

Let  $a = 1$  and  $b = 2$ . Then because  $1 \leq 2^3$ ,  $(1,2) \in R$ . So,  $(2,1) \in R$ .

Now, we need to check if  $(2,1) \in R$ , i.e., if  $2 \leq 1^3$ . This is false.

Therefore, the relation is not symmetric.

#### Step 3: Check for Transitivity

A relation is transitive if whenever  $(a,b) \in R$  and  $(b,c) \in R$ , then  $(a,c) \in R$ . In other words, if  $a \leq b^3$  and  $b \leq c^3$ , then  $a \leq c^3$  must be true.

Let  $a = 1$ ,  $b = 2$ , and  $c = 3$ .

Then  $(1,2) \in R$ , which is true.

And  $(2,3) \in R$ , which is also true since  $2 \leq 3^3$ .

Now, we need to check if  $(1,3) \in R$ , i.e., if  $1 \leq 3^3$ . This is false.

Therefore, the relation is not transitive.

**Final Answer:** The relation is neither reflexive nor symmetric nor transitive.

### ANSWER

Neither reflexive nor symmetric nor transitive.

## Question 6

### QUESTION

Show that the relation  $R$  in the set  $\{1,2,3\}$  given by  $R = \{(1,2), (2,1)\}$  is symmetric but neither reflexive nor transitive.

### SOLUTION

We are given a relation on the set defined as  $R$ . We need to determine if  $R$  is reflexive, symmetric, and transitive.

#### Step 1: Check for Reflexivity

For  $R$  to be reflexive, it must contain  $(a,a)$  for all  $a \in \{1,2,3\}$ . In other words,  $(1,1)$ ,  $(2,2)$ , and  $(3,3)$  must be in  $R$ .

However,  $R$  does not contain  $(1,1)$ ,  $(2,2)$ , or  $(3,3)$ .

Therefore,  $R$  is **not reflexive**.

#### Step 2: Check for Symmetry

For  $R$  to be symmetric, if  $(a,b) \in R$ , then  $(b,a)$  must also be in  $R$ .

We have  $(1,2) \in R$ , and we also have  $(2,1) \in R$ .

Since the condition for symmetry is satisfied,  $R$  is **symmetric**.

#### Step 3: Check for Transitivity

For  $R$  to be transitive, if  $(a,b) \in R$  and  $(b,c) \in R$ , then  $(a,c)$  must also be in  $R$ .

We have  $(1,2) \in R$  and  $(2,1) \in R$ . For  $R$  to be transitive,  $(1,1)$  must be in  $R$ .

However,  $(1,1) \notin R$ .

Therefore,  $R$  is **not transitive**.

**Final Answer:** The relation is symmetric but neither reflexive nor transitive.

### ANSWER

The relation  $R = \{(1,2), (2,1)\}$  is symmetric but neither reflexive nor transitive.

## Question 7

### QUESTION

Show that the relation  $R$  in the set  $A$  of all the books in a library of a college, given by  $R = \{(x,y) : x \text{ and } y \text{ have same number of pages}\}$ , is an equivalence relation.

### SOLUTION

We need to show that the relation defined on the set of all books in a library, where  $R$ , is an equivalence relation. To prove this, we must demonstrate that  $R$  is reflexive, symmetric, and transitive.

#### Step 1: Reflexivity

For  $R$  to be reflexive, we need to show that for all  $x \in A$ ,  $(x,x) \in R$ . In other words, a book must have the same number of pages as itself. This is clearly true since any book will always have the same number of pages as itself. Therefore,  $R$  is reflexive.

#### Step 2: Symmetry

For  $R$  to be symmetric, we need to show that if  $(x,y) \in R$ , then  $(y,x) \in R$ . This means if book  $x$  has the same number of pages as book  $y$ , then book  $y$  must have the same number of pages as book  $x$ . This is also clearly true. If  $x$  and  $y$  have the same number of pages, then it doesn't matter which order we consider them in; the statement remains true. Therefore,  $R$  is symmetric.

#### Step 3: Transitivity

For  $R$  to be transitive, we need to show that if  $(x,y) \in R$  and  $(y,z) \in R$ , then  $(x,z) \in R$ . This means if book  $x$  has the same number of pages as book  $y$ , and book  $y$  has the same number of pages as book  $z$ , then book  $x$  must have the same number of pages as book  $z$ . This is also true. If  $x$  and  $y$  have the same number of pages, and  $y$  and  $z$  have the same number of pages, then  $x$  and  $z$  must also have the same number of pages. Therefore,  $R$  is transitive.

#### Conclusion:

Since  $R$  is reflexive, symmetric, and transitive, it is an equivalence relation.

### ANSWER

The relation  $R = \{(x,y) : x \text{ and } y \text{ have same number of pages}\}$  is an equivalence relation (reflexive, symmetric and transitive).

## Question 8

### QUESTION

Show that the relation  $R$  in the set  $A = \{1, 2, 3, 4, 5\}$  given by  $R = \{(a, b) : |a - b| \text{ is even}\}$  is an equivalence relation. Show that all the elements of  $\{1, 3, 5\}$  are related to each other and all the elements of  $\{2, 4\}$  are related to each other but no element of  $\{1, 3, 5\}$  is related to any element of  $\{2, 4\}$ .

### SOLUTION

We are given a relation on the set defined by . We need to prove that is an equivalence relation and then show the relationships between the elements of the subsets and .

#### Step 1: Prove that is reflexive

For to be reflexive, we need for all . This means must be even for all .

Since , and 0 is an even number, for all . Therefore, is reflexive.

#### Step 2: Prove that is symmetric

For to be symmetric, if , then . This means if is even, then must also be even.

We know that . If is even, then is also even. Thus, if , then . Therefore, is symmetric.

#### Step 3: Prove that is transitive

For to be transitive, if and , then . This means if is even and is even, then must also be even.

If is even, then is even. Similarly, if is even, then is even. The sum of two even numbers is even, so is even. Therefore, is even, and . Thus, is transitive.

Since is reflexive, symmetric, and transitive, is an equivalence relation.

#### Step 4: Analyze the subsets and

For any two elements in , the absolute difference is even: , , . Thus, all elements in are related to each other.

For any two elements in , the absolute difference is even: . Thus, all elements in are related to each other.

For any element from and any element from , the absolute difference is odd: , , , , . Thus, no element of is related to any element of .

**Final Answer:** The relation on is an equivalence relation. The elements form one equivalence class and form another; no element of is related to any element of .

### ANSWER

The relation  $R = \{(a,b) : |a - b| \text{ is even}\}$  on  $A = \{1,2,3,4,5\}$  is an equivalence relation. The elements 1,3,5 form one equivalence class and 2,4 form another; no element of  $\{1,3,5\}$  is related to any element of  $\{2,4\}$ .

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### Question 9

#### QUESTION

Show that each of the relations  $R$  in the set  $A = \{x \in \mathbb{Z} : 0 \leq x \leq 12\}$ , given by

1.  $R = \{(a,b) : |a - b| \text{ is a multiple of } 4\}$
2.  $R = \{(a,b) : a = b\}$

is an equivalence relation. Find the set of all elements related to 1 in each case.

#### SOLUTION

This question requires us to prove that the given relations are equivalence relations and then find the set of elements related to 1 in each case. To prove a relation is an equivalence relation, we need to show it is reflexive, symmetric, and transitive.

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(i) is a multiple of

##### Step 1: Reflexive

For to be reflexive, for all . This means must be a multiple of 4. Since , and 0 is a multiple of 4, is reflexive.

##### Step 2: Symmetric

For to be symmetric, if , then . If is a multiple of 4, then must also be a multiple of 4. Since , if is a multiple of 4, so is . Thus, is symmetric.

##### Step 3: Transitive

For to be transitive, if and , then . If is a multiple of 4 and is a multiple of 4, then and for some integers and . We need to show that is also a multiple of 4. Consider . Then . Since and are multiples of 4, their sum or difference will also be a multiple of 4. Therefore, is a multiple of 4, and is transitive.

##### Step 4: Elements related to 1

We need to find all such that is a multiple of 4. We test values in :

.....

The multiples of 4 are 0, 4, and 8. Thus, the elements related to 1 are 1, 5, and 9. The set is .

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(ii)

##### Step 1: Reflexive

For to be reflexive, for all . Since , is reflexive.

##### Step 2: Symmetric

For to be symmetric, if , then . If , then . Thus, is symmetric.

##### Step 3: Transitive

For to be transitive, if and , then . If and , then . Thus, is transitive.

**Step 4: Elements related to 1**

We need to find all such that . The only element that satisfies this condition is 1. The set is .

**ANSWER**

Both (i) and (ii) define equivalence relations on A. The set of all elements related to 1 is:

(i)  $\{1, 5, 9\}$

(ii)  $\{1\}$

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## Question 10

### QUESTION

Give an example of a relation which is:

1. Symmetric but neither reflexive nor transitive.
2. Transitive but neither reflexive nor symmetric.
3. Reflexive and symmetric but not transitive.
4. Reflexive and transitive but not symmetric.
5. Symmetric and transitive but not reflexive.

### SOLUTION

This question tests our understanding of reflexive, symmetric, and transitive relations. We need to provide examples that satisfy some properties but not others.

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#### (i) Symmetric but neither reflexive nor transitive.

Let's consider a set and a relation .

##### Step 1: Check for symmetry.

Since and , the relation is symmetric.

##### Step 2: Check for reflexivity.

For to be reflexive, , , and must be in . None of these are in , so is not reflexive.

##### Step 3: Check for transitivity.

We have and . For to be transitive, must be in . Since , the relation is not transitive.

**Final Answer:** On , is symmetric but neither reflexive nor transitive.

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#### (ii) Transitive but neither reflexive nor symmetric.

Let (the set of integers) and .

##### Step 1: Check for transitivity.

If and , then and . This implies , so . Thus, is transitive.

##### Step 2: Check for reflexivity.

For to be reflexive, must be in for all . However, is never true, so . Thus, is not reflexive.

##### Step 3: Check for symmetry.

If , then . This means is false, so . Thus, is not symmetric.

**Final Answer:** On , is transitive but neither reflexive nor symmetric.

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**(iii) Reflexive and symmetric but not transitive.**

Let and .

**Step 1: Check for reflexivity.**

For any , , so . Thus, is reflexive.

**Step 2: Check for symmetry.**

If , then or . If , then . If , then . In either case, , so is symmetric.

**Step 3: Check for transitivity.**

Let , , and . Then because and because . However, . Now, consider , , and . Then and . However, if we take , then and but is not related to in this way. For example, and , but . However, if we take , then and . Consider . Then and . However, . Let . Then and . Then . However, if we let on , then is reflexive and symmetric, but not transitive because and but .

If and and , then and , so . However, if and and , then and , so . Thus, is transitive.

Consider on . Then is reflexive because . is symmetric because if , then . However, is not transitive. For example, and , but .

**Final Answer:** On , is reflexive and symmetric but not transitive.

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**(iv) Reflexive and transitive but not symmetric.**

Let and .

**Step 1: Check for reflexivity.**

For any , , so . Thus, is reflexive.

**Step 2: Check for transitivity.**

If and , then and . This implies , so . Thus, is transitive.

**Step 3: Check for symmetry.**

If , then . This does not imply . For example, but . Thus, is not symmetric.

**Final Answer:** On , is reflexive and transitive but not symmetric.

---

**(v) Symmetric and transitive but not reflexive.**

Let and .

**Step 1: Check for symmetry.**

If , then . This implies , so . Thus, is symmetric.

**Step 2: Check for transitivity.**

If and , then and . This implies , so . Thus, is transitive.

**Step 3: Check for reflexivity.**

For to be reflexive, must be in for all . However, since . Thus, is not reflexive.

**Final Answer:** On , is symmetric and transitive but not reflexive.

### ANSWER

Examples may vary. One possible set of examples is:

(i) On  $A = \{1, 2, 3\}$ , let  $R = \{(1, 2), (2, 1)\}$ .

(ii) On  $A = \mathbb{Z}$ , let  $R = \{(a, b) : a < b\}$ .

(iii) On  $A = \mathbb{R}$ , let  $R = \{(a, b) : a = b \text{ or } a = -b\}$ .

(iv) On  $A = \mathbb{R}$ , let  $R = \{(a, b) : a \leq b\}$ .

(v) On  $A = \mathbb{R}$ , let  $R = \{(a, b) : a = b = 0\}$ .

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## Question 11

### QUESTION

Show that the relation  $R$  in the set  $A$  of points in a plane given by  $R = \{(P, Q) : \text{distance of the point } P \text{ from the origin is same as the distance of the point } Q \text{ from the origin}\}$  is an equivalence relation. Further, show that the set of all points related to a point  $P \neq (0,0)$  is the circle passing through  $P$  with origin as centre.

### SOLUTION

We are given a relation defined on a set of points in a plane. The relation connects two points and if they are equidistant from the origin. We need to prove that is an equivalence relation and describe the set of all points related to a non-origin point .

#### Step 1: Proving Reflexivity

For to be reflexive, for all . This means the distance of point from the origin must be the same as the distance of point from the origin, which is obviously true. Therefore, is reflexive.

#### Step 2: Proving Symmetry

For to be symmetric, if , then . If , the distance of from the origin is equal to the distance of from the origin. This also means the distance of from the origin is equal to the distance of from the origin. Therefore, , and is symmetric.

#### Step 3: Proving Transitivity

For to be transitive, if and , then . If , the distance of from the origin is equal to the distance of from the origin. If , the distance of from the origin is equal to the distance of from the origin. Therefore, the distance of from the origin is equal to the distance of from the origin, which means . Thus, is transitive.

#### Step 4: Conclude Equivalence Relation

Since is reflexive, symmetric, and transitive, it is an equivalence relation.

#### Step 5: Describing the set of points related to

Let be a point in the plane. The set of all points related to under are those points whose distance from the origin is the same as the distance of from the origin. This is the definition of a circle with the origin as the center and the radius equal to the distance of from the origin. Therefore, the set of all points related to is the circle passing through with the origin as the center.

### ANSWER

The relation  $R$  defined by equality of distance from the origin is an equivalence relation (reflexive, symmetric and transitive). For a fixed point  $P \neq (0,0)$ , the set of all points related to  $P$  is the circle with centre at the origin and radius equal to the distance of  $P$  from the origin; this circle passes through  $P$ .

## Question 12

### QUESTION

Show that the relation  $R$  defined in the set  $A$  of all triangles as  $R = \{(T_1, T_2) : T_1 \text{ is similar to } T_2\}$  is an equivalence relation. Consider three right angle triangles  $T_1$  with sides 3,4,5,  $T_2$  with sides 5,12,13 and  $T_3$  with sides 6,8,10. Which triangles among  $T_1$ ,  $T_2$  and  $T_3$  are related?

### SOLUTION

We need to prove that the given relation on the set of all triangles, defined as  $R = \{(T_1, T_2) : T_1 \text{ is similar to } T_2\}$ , is an equivalence relation. Then, we need to determine which of the given right-angled triangles are related.

#### Step 1: Prove Reflexivity

For  $R$  to be reflexive, we need to show that  $T_1$  is similar to  $T_1$  for all triangles in  $A$ . Since every triangle is similar to itself,  $R$  is reflexive.

#### Step 2: Prove Symmetry

For  $R$  to be symmetric, if  $T_1$  is similar to  $T_2$ , then  $T_2$  must be similar to  $T_1$ . If  $T_2$  is similar to  $T_1$ , then  $T_1$  is similar to  $T_2$ . Similarity is a symmetric property, so  $R$  is also similar to  $T_2$ , which means  $R$  is symmetric.

#### Step 3: Prove Transitivity

For  $R$  to be transitive, if  $T_1$  is similar to  $T_2$  and  $T_2$  is similar to  $T_3$ , then  $T_1$  must be similar to  $T_3$ . If  $T_1$  and  $T_2$  are similar to  $T_3$ , then  $T_1$  is similar to  $T_3$ . Similarity is a transitive property, so  $R$  is similar to  $T_3$ , which means  $R$  is transitive.

#### Step 4: Conclude Equivalence Relation

Since  $R$  is reflexive, symmetric, and transitive,  $R$  is an equivalence relation.

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#### Step 5: Determine which triangles are related

We are given three triangles:  $T_1$  with sides 3, 4, 5,  $T_2$  with sides 5, 12, 13, and  $T_3$  with sides 6, 8, 10.

For two triangles to be similar, their corresponding sides must be in proportion.

Comparing  $T_1$  and  $T_2$ :

$\frac{3}{5} \neq \frac{4}{12} \neq \frac{5}{13}$ . Since the ratios of corresponding sides are not equal,  $T_1$  and  $T_2$  are not similar.

Comparing  $T_1$  and  $T_3$ :

$\frac{3}{6} = \frac{4}{8} = \frac{5}{10} = \frac{1}{2}$ . Since the ratios of corresponding sides are equal,  $T_1$  and  $T_3$  are similar.

Comparing  $T_2$  and  $T_3$ :

$\frac{5}{6} \neq \frac{12}{8} \neq \frac{13}{10}$ . Since the ratios of corresponding sides are not equal,  $T_2$  and  $T_3$  are not similar.

**Final Answer:** The relation "is similar to" on the set of all triangles is an equivalence relation. Among the given triangles,  $T_1$  (sides 3, 4, 5) is similar to  $T_3$  (sides 6, 8, 10), so  $T_1$  is related to  $T_3$ .

### ANSWER

The relation R "is similar to" on the set of all triangles is an equivalence relation. Among the given triangles,  $T_1$  (sides 3,4,5) is similar to  $T_3$  (sides 6,8,10), so  $T_1$  is related to  $T_3$ .

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### Question 13

#### QUESTION

Show that the relation  $R$  defined in the set  $A$  of all polygons as  $R = \{(P_1, P_2) : P_1 \text{ and } P_2 \text{ have same number of sides}\}$  is an equivalence relation. What is the set of all elements in  $A$  related to the right angled triangle  $T$  with sides 3,4 and 5?

#### SOLUTION

We are given a relation on the set of all polygons, defined as  $R$ . We need to prove that  $R$  is an equivalence relation and find the set of all elements in  $A$  related to a right-angled triangle with sides 3, 4, and 5.

##### Step 1: Proving $R$ is an equivalence relation

To prove that  $R$  is an equivalence relation, we need to show that it is reflexive, symmetric, and transitive.

##### Step 2: Reflexive

For any polygon  $P$  in  $A$ ,  $P$  has the same number of sides as itself. Therefore,  $(P, P) \in R$ . Hence,  $R$  is reflexive.

##### Step 3: Symmetric

If  $(P, Q) \in R$ , then  $P$  and  $Q$  have the same number of sides. This implies that  $Q$  and  $P$  also have the same number of sides. Therefore,  $(Q, P) \in R$ . Hence,  $R$  is symmetric.

##### Step 4: Transitive

If  $(P, Q) \in R$  and  $(Q, R) \in R$ , then  $P$  and  $Q$  have the same number of sides, and  $Q$  and  $R$  have the same number of sides. This implies that  $P$  and  $R$  have the same number of sides. Therefore,  $(P, R) \in R$ . Hence,  $R$  is transitive.

Since  $R$  is reflexive, symmetric, and transitive, it is an equivalence relation.

---

##### Step 5: Finding the set of all elements related to triangle $T$

The right-angled triangle  $T$  has three sides. We need to find all polygons in  $A$  that are related to  $T$ . This means we need to find all polygons in  $A$  that have the same number of sides as  $T$ .

Since  $T$  is a triangle, it has three sides. Therefore, any polygon related to  $T$  must also have three sides. The set of all polygons with three sides is the set of all triangles.

**Final Answer:** The relation  $R$  is an equivalence relation. The set of all elements in  $A$  related to the right angled triangle  $T$  is the set of all triangles (all polygons having three sides).

#### ANSWER

The relation  $R$  is an equivalence relation. The set of all elements in  $A$  related to the right angled triangle  $T$  is the set of all triangles (all polygons having three sides).

## Question 14

### QUESTION

Let  $L$  be the set of all lines in the  $XY$ -plane and  $R$  be the relation in  $L$  defined as  $R = \{(L_1, L_2) : L_1 \text{ is parallel to } L_2\}$ . Show that  $R$  is an equivalence relation. Find the set of all lines related to the line  $y = 2x + 4$ .

### SOLUTION

We are given a relation on the set of all lines in the  $XY$ -plane, defined as  $R = \{(L_1, L_2) : L_1 \text{ is parallel to } L_2\}$ . We need to show that  $R$  is an equivalence relation and find the set of all lines related to the line  $y = 2x + 4$ .

#### Step 1: Check for Reflexivity

A relation is reflexive if for all  $L \in L$ ,  $L R L$ . Since every line is parallel to itself,  $L R L$ . Therefore,  $R$  is reflexive.

#### Step 2: Check for Symmetry

A relation is symmetric if whenever  $L_1 R L_2$ , then  $L_2 R L_1$ . If  $L_1$  is parallel to  $L_2$ , then  $L_2$  is also parallel to  $L_1$ . Thus, if  $L_1 R L_2$ , then  $L_2 R L_1$ , and  $R$  is symmetric.

#### Step 3: Check for Transitivity

A relation is transitive if whenever  $L_1 R L_2$  and  $L_2 R L_3$ , then  $L_1 R L_3$ . If  $L_1$  is parallel to  $L_2$  and  $L_2$  is parallel to  $L_3$ , then  $L_1$  is also parallel to  $L_3$ . Thus, if  $L_1 R L_2$  and  $L_2 R L_3$ , then  $L_1 R L_3$ , and  $R$  is transitive.

#### Step 4: Conclude that $R$ is an Equivalence Relation

Since  $R$  is reflexive, symmetric, and transitive,  $R$  is an equivalence relation.

#### Step 5: Find the set of all lines related to $y = 2x + 4$

A line is related to  $y = 2x + 4$  if it is parallel to it. Parallel lines have the same slope. The slope of the line is 2. Therefore, any line parallel to it will have the form  $y = 2x + c$ , where  $c$  is any real number.

**Final Answer:** The set of all lines related to the line  $y = 2x + 4$  is the set of all lines of the form  $y = 2x + c$ , where  $c \in \mathbb{R}$ .

### ANSWER

The relation  $R$  "is parallel to" is an equivalence relation. The set of all lines related to the line  $y = 2x + 4$  is the set of all lines of the form  $y = 2x + c$ , where  $c \in \mathbb{R}$ .

## Question 15

### QUESTION

Let  $R$  be the relation in the set  $\{1,2,3,4\}$  given by  $R = \{(1,2), (2,2), (1,1), (4,4), (1,3), (3,3), (3,2)\}$ . Choose the correct answer.

- (A)  $R$  is reflexive and symmetric but not transitive.
- (B)  $R$  is reflexive and transitive but not symmetric.
- (C)  $R$  is symmetric and transitive but not reflexive.
- (D)  $R$  is an equivalence relation.

### SOLUTION

We are given a relation on the set and asked to determine its properties: reflexive, symmetric, and transitive.

#### Step 1: Check for Reflexivity

For  $R$  to be reflexive,  $(a,a)$  must be in  $R$  for all  $a$  in  $\{1,2,3,4\}$ . In other words,  $(1,1)$ ,  $(2,2)$ ,  $(3,3)$ , and  $(4,4)$  must all be in  $R$ . Looking at the given relation, we see that  $(1,1)$ ,  $(2,2)$ , and  $(3,3)$  are indeed in  $R$ . Thus,  $R$  is reflexive.

#### Step 2: Check for Symmetry

For  $R$  to be symmetric, if  $(a,b)$  is in  $R$ , then  $(b,a)$  must also be in  $R$ . We have  $(1,2)$  in  $R$ , but  $(2,1)$  is not in  $R$ . Therefore,  $R$  is not symmetric. We can stop here since we only need one counterexample.

#### Step 3: Check for Transitivity

For  $R$  to be transitive, if  $(a,b)$  and  $(b,c)$  are in  $R$ , then  $(a,c)$  must also be in  $R$ . Let's examine the pairs:

- $(1,2)$  and  $(2,2)$  are in  $R$ . Then  $(1,2)$  must be in  $R$ , which it is.
- $(1,2)$  and  $(2,3)$  are in  $R$ . Then  $(1,3)$  must be in  $R$ , which it is.
- $(1,3)$  and  $(3,3)$  are in  $R$ . Then  $(1,3)$  must be in  $R$ , which it is.
- $(1,3)$  and  $(3,2)$  are in  $R$ . Then  $(1,2)$  must be in  $R$ , which it is.
- $(2,2)$  and  $(2,3)$  are in  $R$ . Then  $(2,3)$  must be in  $R$ , which it is.

After checking all pairs, we find that  $R$  is transitive.

#### Step 4: Conclusion

Since  $R$  is reflexive and transitive but not symmetric, the correct answer is (B).

### ANSWER

(B)  $R$  is reflexive and transitive but not symmetric.

## Question 16

### QUESTION

Let  $R$  be the relation in the set  $\mathbb{N}$  given by  $R = \{(a,b) : a = b - 2, b > 6\}$ . Choose the correct answer.

(A)  $(2,4) \in R$

(B)  $(3,8) \in R$

(C)  $(6,8) \in R$

(D)  $(8,7) \in R$

### SOLUTION

We are given a relation defined on the set of natural numbers as  $R = \{(a,b) : a = b - 2, b > 6\}$ . We need to determine which of the given ordered pairs belongs to this relation.

#### Step 1: Understand the relation

The relation consists of ordered pairs where  $a$  and  $b$  are natural numbers. The condition for  $(a,b)$  to be in  $R$  is that  $a$  must be equal to  $b - 2$ , and  $b$  must be greater than 6.

#### Step 2: Check option (A):

Here,  $a = 2$  and  $b = 4$ . We need to check if  $a = b - 2$  and  $b > 6$ .

Is  $2 = 4 - 2$ ? Yes,  $2 = 2$ .

Is  $4 > 6$ ? No,  $4$  is not greater than  $6$ .

Therefore,  $(2,4) \notin R$ .

#### Step 3: Check option (B):

Here,  $a = 3$  and  $b = 8$ . We need to check if  $a = b - 2$  and  $b > 6$ .

Is  $3 = 8 - 2$ ? No,  $3 \neq 6$ .

Is  $8 > 6$ ? Yes,  $8$  is greater than  $6$ .

Since the first condition is not met,  $(3,8) \notin R$ .

#### Step 4: Check option (C):

Here,  $a = 6$  and  $b = 8$ . We need to check if  $a = b - 2$  and  $b > 6$ .

Is  $6 = 8 - 2$ ? Yes,  $6 = 6$ .

Is  $8 > 6$ ? Yes,  $8$  is greater than  $6$ .

Therefore,  $(6,8) \in R$ .

**Step 5: Check option (D):**

Here, and . We need to check if and .

Is ? No, .

Is ? Yes, is greater than .

Since the first condition is not met, .

**Final Answer:** (C) .

**ANSWER**

(C)  $(6,8) \in R$ .

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## Key Formulas

### Important Formulas for Exercise 1.1

Formula / Concept	Description
Relation in a Set	A relation $R$ in a set $A$ is a subset of the Cartesian product $A \times A$ .
Empty Relation	A relation $R$ in a set $A$ is called an empty relation if no element of $A$ is related to any element of $A$ . i.e., $R = \emptyset \subset A \times A$
Universal Relation	A relation $R$ in a set $A$ is called a universal relation if each element of $A$ is related to every element of $A$ . i.e., $R = A \times A$
Reflexive Relation	A relation $R$ in a set $A$ is called reflexive if $(a, a) \in R$ for every $a \in A$ .

Formula / Concept	Description
Symmetric Relation	A relation $R$ in a set $A$ is called symmetric if $(a_1, a_2) \in R$ implies that $(a_2, a_1) \in R$ for all $a_1, a_2 \in A$ .
Transitive Relation	A relation $R$ in a set $A$ is called transitive if $(a_1, a_2) \in R$ and $(a_2, a_3) \in R$ implies that $(a_1, a_3) \in R$ for all $a_1, a_2, a_3 \in A$ .
Equivalence Relation	A relation $R$ in a set $A$ is an equivalence relation if it is reflexive, symmetric, and transitive.

## 7 Top FAQs

### Q1. How many questions are in NCERT Solutions Class 12 Maths Chapter 1 Relations and Functions Exercise 1.1?

Exercise 1.1 of NCERT Solutions for Class 12 Maths Chapter 1 Relations and Functions contains exactly 16 questions. These questions cover various types of relations including reflexive, symmetric, transitive, and equivalence relations. All step by step solutions are available for free PDF download for CBSE board exam 2025-26 preparation.

### Q2. Where can I download free PDF of NCERT Solutions for Class 12 Maths Chapter 1 Relations and Functions Exercise 1.1?

You can download the free PDF of NCERT Solutions for Class 12 Maths Chapter 1 Relations and Functions Exercise 1.1 from the official NCERT website or various educational portals. These step by step solutions are updated as per the CBSE syllabus 2025-26 and include detailed explanations for all 16 questions on types of relations.

### Q3. How many marks does Relations and Functions carry in CBSE Class 12 Maths board exam 2025-26?

Relations and Functions (Chapter 1) carries 4 marks weightage in CBSE Class 12 Maths board exam 2025-26 as part of Unit I. Exercise 1.1 focuses on types of relations which is crucial for scoring full marks. Students should practice NCERT Solutions for Class 12 Maths Chapter 1 Exercise 1.1 thoroughly for board exam preparation.

### Q4. Which is the most difficult question in Exercise 1.1 of NCERT Solutions Class 12 Maths Chapter 1 Relations and Functions?

Questions 13 to 16 in Exercise 1.1 of NCERT Solutions for Class 12 Maths Chapter 1 Relations and Functions are considered most difficult as they involve proving equivalence relations and finding equivalence classes. These questions require deep understanding of types of relations and their properties. Step by step solutions with detailed explanations help students solve these challenging problems for CBSE board exam 2025-26.

## Q5. What is Types of Relations covered in NCERT Solutions for Class 12 Maths Chapter 1 Exercise 1.1?

Exercise 1.1 of NCERT Solutions for Class 12 Maths Chapter 1 Relations and Functions covers five types of relations: Empty relation, Universal relation, Reflexive relation, Symmetric relation, and Transitive relation. Students also learn about Equivalence relations which combine all three properties. These concepts are essential for CBSE Class 12 board exam 2025-26 and require thorough practice with step by step solutions.


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