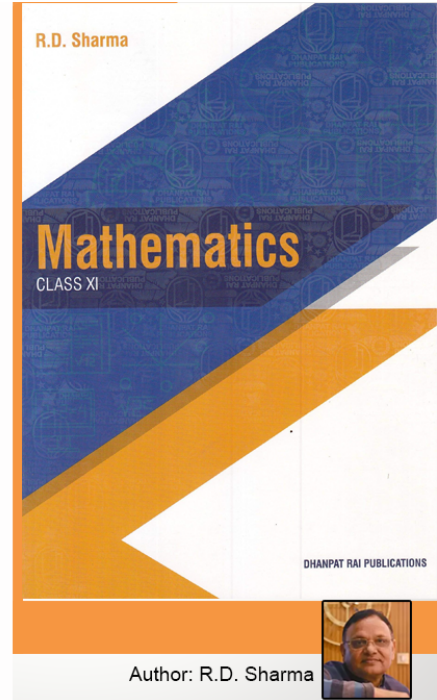


# Class 11 - Chapter 2 Relations



## RD Sharma Solutions for Class 11 Maths Chapter 2–Relations

Class 11: Maths Chapter 2 solutions. Complete Class 11 Maths Chapter 2 Notes.

### RD Sharma Solutions for Class 11 Maths Chapter 2–Relations

RD Sharma 11th Maths Chapter 2, Class 11 Maths Chapter 2 solutions

EXERCISE 2.1 PAGE NO: 2.8

(1) (i) If  $(a/3 + 1, b - 2/3) = (5/3, 1/3)$ , find the values of a and b.

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(ii) If  $(x + 1, 1) = (3y, y - 1)$ , find the values of  $x$  and  $y$ .

**Solution:**

**Given:**

$$(a/3 + 1, b - 2/3) = (5/3, 1/3)$$

**By the definition of equality of ordered pairs,**

**Let us solve for  $a$  and  $b$**

$$a/3 + 1 = 5/3 \text{ and } b - 2/3 = 1/3$$

$$a/3 = 5/3 - 1 \text{ and } b = 1/3 + 2/3$$

$$a/3 = (5-3)/3 \text{ and } b = (1+2)/3$$

$$a/3 = 2/3 \text{ and } b = 3/3$$

$$a = 2(3)/3 \text{ and } b = 1$$

$$a = 2 \text{ and } b = 1$$

$\therefore$  Values of  $a$  and  $b$  are,  $a = 2$  and  $b = 1$

(ii) If  $(x + 1, 1) = (3y, y - 1)$ , find the values of  $x$  and  $y$ .

**Given:**

$$(x + 1, 1) = (3y, y - 1)$$

**By the definition of equality of ordered pairs,**

**Let us solve for  $x$  and  $y$**

$$x + 1 = 3y \text{ and } 1 = y - 1$$

$$x = 3y - 1 \text{ and } y = 1 + 1$$

$$x = 3y - 1 \text{ and } y = 2$$

**Since,  $y = 2$  we can substitute in**

$$x = 3y - 1$$

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$$= 3(2) - 1$$

$$= 6 - 1$$

$$= 5$$

∴ Values of x and y are,  $x = 5$  and  $y = 2$

2. If the ordered pairs  $(x, -1)$  and  $(5, y)$  belong to the set  $\{(a, b): b = 2a - 3\}$ , find the values of x and y.

**Solution:**

**Given:**

The ordered pairs  $(x, -1)$  and  $(5, y)$  belong to the set  $\{(a, b): b = 2a - 3\}$

**Solving for first order pair**

$$(x, -1) = \{(a, b): b = 2a - 3\}$$

$$x = a \text{ and } -1 = b$$

**By taking  $b = 2a - 3$**

$$\text{If } b = -1 \text{ then } 2a = -1 + 3$$

$$= 2$$

$$a = 2/2$$

$$= 1$$

**So,  $a = 1$**

**Since  $x = a$ ,  $x = 1$**

**Similarly, solving for second order pair**

$$(5, y) = \{(a, b): b = 2a - 3\}$$

$$5 = a \text{ and } y = b$$

**By taking  $b = 2a - 3$**

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If  $a = 5$  then  $b = 2 \times 5 - 3$

$= 10 - 3$

$= 7$

So,  $b = 7$

Since  $y = b$ ,  $y = 7$

$\therefore$  Values of  $x$  and  $y$  are,  $x = 1$  and  $y = 7$

3. If  $a \in \{-1, 2, 3, 4, 5\}$  and  $b \in \{0, 3, 6\}$ , write the set of all ordered pairs  $(a, b)$  such that  $a + b = 5$ .

**Solution:**

Given:  $a \in \{-1, 2, 3, 4, 5\}$  and  $b \in \{0, 3, 6\}$ ,

To find: the ordered pair  $(a, b)$  such that  $a + b = 5$

Then the ordered pair  $(a, b)$  such that  $a + b = 5$  are as follows

$(a, b) \in \{(-1, 6), (2, 3), (5, 0)\}$

4. If  $a \in \{2, 4, 6, 9\}$  and  $b \in \{4, 6, 18, 27\}$ , then form the set of all ordered pairs  $(a, b)$  such that  $a$  divides  $b$  and  $a < b$ .

**Solution:**

Given:

$a \in \{2, 4, 6, 9\}$  and  $b \in \{4, 6, 18, 27\}$

Here,

2 divides 4, 6, 18 and is also less than all of them

4 divides 4 and is also less than none of them

6 divides 6, 18 and is less than 18 only

9 divides 18, 27 and is less than all of them

$\therefore$  Ordered pairs  $(a, b)$  are  $(2, 4)$ ,  $(2, 6)$ ,  $(2, 18)$ ,  $(6, 18)$ ,  $(9, 18)$  and  $(9, 27)$

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

**Solution:**

**Given:**

$$A = \{1, 2\} \text{ and } B = \{1, 3\}$$

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

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

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

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

6. Let  $A = \{1, 2, 3\}$  and  $B = \{3, 4\}$ . Find  $A \times B$  and show it graphically

**Solution:**

**Given:**

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

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

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

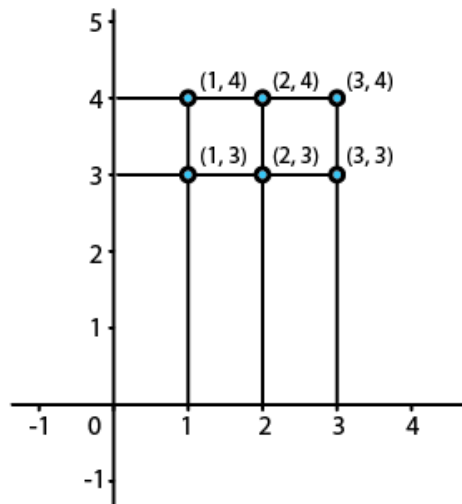
**Steps to follow to represent  $A \times B$  graphically,**

**Step 1: One horizontal and one vertical axis should be drawn**

**Step 2: Element of set A should be represented in horizontal axis and on vertical axis elements of set B should be represented**

**Step 3: Draw dotted lines perpendicular to horizontal and vertical axes through the elements of set A and B**

**Step 4: Point of intersection of these perpendicular represents  $A \times B$**



7. If  $A = \{1, 2, 3\}$  and  $B = \{2, 4\}$ , what are  $A \times B$ ,  $B \times A$ ,  $A \times A$ ,  $B \times B$ , and  $(A \times B) \cap (B \times A)$ ?

**Solution:**

**Given:**

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

Now let us find:  $A \times B$ ,  $B \times A$ ,  $A \times A$ ,  $(A \times B) \cap (B \times A)$

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

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

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

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

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

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

$$B \times B = \{2, 4\} \times \{2, 4\}$$

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

Intersection of two sets represents common elements of both the sets

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So,

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

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**EXERCISE 2.2 PAGE NO: 2.12**

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

**Solution:**

**Given:**

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

Let us find:  $(A \times B) \cap (B \times C)$

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

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

$$(B \times C) = \{3, 4\} \times \{4, 5, 6\}$$

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

$$\therefore (A \times B) \cap (B \times C) = \{(3, 4)\}$$

2. If  $A = \{2, 3\}$ ,  $B = \{4, 5\}$ ,  $C = \{5, 6\}$  find  $A \times (B \cup C)$ ,  $(A \times B) \cup (A \times C)$ .

**Solution:**

**Given:**  $A = \{2, 3\}$ ,  $B = \{4, 5\}$  and  $C = \{5, 6\}$

Let us find:  $A \times (B \cup C)$  and  $(A \times B) \cup (A \times C)$

$$(B \cup C) = \{4, 5, 6\}$$

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

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

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

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

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$$(A \times C) = \{2, 3\} \times \{5, 6\}$$

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

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

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

3. If  $A = \{1, 2, 3\}$ ,  $B = \{4\}$ ,  $C = \{5\}$ , then verify that:

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

(ii)  $A \times (B \cap C) = (A \times B) \cap (A \times C)$

(iii)  $A \times (B - C) = (A \times B) - (A \times C)$

**Solution:**

**Given:**

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

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

Let us consider LHS:  $(B \cup C)$

$$(B \cup C) = \{4, 5\}$$

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

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

Now, RHS

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

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

$$(A \times C) = \{1, 2, 3\} \times \{5\}$$

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

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

$$\therefore \text{LHS} = \text{RHS}$$

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$$(ii) A \times (B \cap C) = (A \times B) \cap (A \times C)$$

Let us consider LHS:  $(B \cap C)$

$$(B \cap C) = \emptyset \text{ (No common element)}$$

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

$$= \emptyset$$

Now, RHS

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

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

$$(A \times C) = \{1, 2, 3\} \times \{5\}$$

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

$$(A \times B) \cap (A \times C) = \emptyset$$

$$\therefore \text{LHS} = \text{RHS}$$

$$(iii) A \times (B - C) = (A \times B) - (A \times C)$$

Let us consider LHS:  $(B - C)$

$$(B - C) = \emptyset$$

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

$$= \emptyset$$

Now, RHS

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

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

$$(A \times C) = \{1, 2, 3\} \times \{5\}$$

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

$$(A \times B) - (A \times C) = \emptyset$$

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∴ LHS = RHS

4. Let  $A = \{1, 2\}$ ,  $B = \{1, 2, 3, 4\}$ ,  $C = \{5, 6\}$  and  $D = \{5, 6, 7, 8\}$ . Verify that:

(i)  $A \times C \subset B \times D$

(ii)  $A \times (B \cap C) = (A \times B) \cap (A \times C)$

**Solution:**

**Given:**

$$A = \{1, 2\}, B = \{1, 2, 3, 4\}, C = \{5, 6\} \text{ and } D = \{5, 6, 7, 8\}$$

(i)  $A \times C \subset B \times D$

Let us consider LHS  $A \times C$

$$A \times C = \{1, 2\} \times \{5, 6\}$$

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

Now, RHS

$$B \times D = \{1, 2, 3, 4\} \times \{5, 6, 7, 8\}$$

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

Since, all elements of  $A \times C$  is in  $B \times D$ .

∴ We can say  $A \times C \subset B \times D$

(ii)  $A \times (B \cap C) = (A \times B) \cap (A \times C)$

Let us consider LHS  $A \times (B \cap C)$

$$(B \cap C) = \emptyset$$

$$A \times (B \cap C) = \{1, 2\} \times \emptyset$$

$$= \emptyset$$

Now, RHS

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

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

$$(A \times C) = \{1, 2\} \times \{5, 6\}$$

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

Since, there is no common element between  $A \times B$  and  $A \times C$

$$(A \times B) \cap (A \times C) = \emptyset$$

$$\therefore A \times (B \cap C) = (A \times B) \cap (A \times C)$$

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

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

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

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

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

**Solution:**

**Given:**

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

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

$$(B \cap C) = \{4\}$$

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

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

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

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

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

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

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

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

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

$$(B \cup C) = \{3, 4, 5, 6\}$$

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

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

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

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

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

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

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

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

6. Prove that:

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

$$(ii) (A \cap B) \times C = (A \times C) \cap (B \times C)$$

Solution:

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

Let  $(x, y)$  be an arbitrary element of  $(A \cup B) \times C$

$$(x, y) \in (A \cup B) \times C$$

Since,  $(x, y)$  are elements of Cartesian product of  $(A \cup B) \times C$

$$x \in (A \cup B) \text{ and } y \in C$$

$$(x \in A \text{ or } x \in B) \text{ and } y \in C$$

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$$(x \in A \text{ and } y \in C) \text{ or } (x \in B \text{ and } y \in C)$$

$$(x, y) \in A \times C \text{ or } (x, y) \in B \times C$$

$$(x, y) \in (A \times C) \cup (B \times C) \dots (1)$$

Let  $(x, y)$  be an arbitrary element of  $(A \times C) \cup (B \times C)$ .

$$(x, y) \in (A \times C) \cup (B \times C)$$

$$(x, y) \in (A \times C) \text{ or } (x, y) \in (B \times C)$$

$$(x \in A \text{ and } y \in C) \text{ or } (x \in B \text{ and } y \in C)$$

$$(x \in A \text{ or } x \in B) \text{ and } y \in C$$

$$x \in (A \cup B) \text{ and } y \in C$$

$$(x, y) \in (A \cup B) \times C \dots (2)$$

From 1 and 2, we get:  $(A \cup B) \times C = (A \times C) \cup (B \times C)$

$$(ii) (A \cap B) \times C = (A \times C) \cap (B \times C)$$

Let  $(x, y)$  be an arbitrary element of  $(A \cap B) \times C$ .

$$(x, y) \in (A \cap B) \times C$$

Since,  $(x, y)$  are elements of Cartesian product of  $(A \cap B) \times C$

$$x \in (A \cap B) \text{ and } y \in C$$

$$(x \in A \text{ and } x \in B) \text{ and } y \in C$$

$$(x \in A \text{ and } y \in C) \text{ and } (x \in B \text{ and } y \in C)$$

$$(x, y) \in A \times C \text{ and } (x, y) \in B \times C$$

$$(x, y) \in (A \times C) \cap (B \times C) \dots (1)$$

Let  $(x, y)$  be an arbitrary element of  $(A \times C) \cap (B \times C)$ .

$$(x, y) \in (A \times C) \cap (B \times C)$$

$$(x, y) \in (A \times C) \text{ and } (x, y) \in (B \times C)$$

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$(x \in A \text{ and } y \in C) \text{ and } (x \in B \text{ and } y \in C)$

$(x \in A \text{ and } x \in B) \text{ and } y \in C$

$x \in (A \cap B) \text{ and } y \in C$

$(x, y) \in (A \cap B) \times C \dots (2)$

From 1 and 2, we get:  $(A \cap B) \times C = (A \times C) \cap (B \times C)$

7. If  $A \times B \subseteq C \times D$  and  $A \cap B = \emptyset$ , Prove that  $A \subseteq C$  and  $B \subseteq D$ .

**Solution:**

**Given:**

$A \times B \subseteq C \times D$  and  $A \cap B = \emptyset$

$A \times B \subseteq C \times D$  denotes  $A \times B$  is subset of  $C \times D$  that is every element  $A \times B$  is in  $C \times D$ .

And  $A \cap B = \emptyset$  denotes  $A$  and  $B$  does not have any common element between them.

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

$\therefore$  We can say  $(a, b) \subseteq C \times D$  [Since,  $A \times B \subseteq C \times D$  is given]

$a \in C$  and  $b \in D$

$a \in A = a \in C$

$A \subseteq C$

And

$b \in B = b \in D$

$B \subseteq D$

Hence proved.

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#### EXERCISE 2.3 PAGE NO: 2.20

1. If  $A = \{1, 2, 3\}$ ,  $B = \{4, 5, 6\}$ , which of the following are relations from  $A$  to  $B$ ?

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Give reasons in support of your answer.

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

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

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

(iv)  $A \times B$

**Solution:**

**Given,**

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

A relation from A to B can be defined as:

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

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

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

No, it is not a relation from A to B. The given set is not a subset of  $A \times B$  as  $(5, 2)$  is not a part of the relation from A to B.

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

Yes, it is a relation from A to B. The given set is a subset of  $A \times B$ .

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

No, it is not a relation from A to B. The given set is not a subset of  $A \times B$ .

(iv)  $A \times B$

$A \times B$  is a relation from A to B and can be defined as:

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

2. A relation R is defined from a set  $A = \{2, 3, 4, 5\}$  to a set  $B = \{3, 6, 7, 10\}$  as follows:  $(x, y) \in R$  if x is relatively prime to y. Express R as a set of ordered pairs and determine its domain and range.

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**Solution:**

Relatively prime numbers are also known as co-prime numbers. If there is no integer greater than one that divides both (that is, their greatest common divisor is one).

Given:  $(x, y) \in R = x$  is relatively prime to  $y$

Here,

2 is co-prime to 3 and 7.

3 is co-prime to 7 and 10.

4 is co-prime to 3 and 7.

5 is co-prime to 3, 6 and 7.

$\therefore R = \{(2, 3), (2, 7), (3, 7), (3, 10), (4, 3), (4, 7), (5, 3), (5, 6), (5, 7)\}$

Domain of relation  $R = \{2, 3, 4, 5\}$

Range of relation  $R = \{3, 6, 7, 10\}$

3. Let  $A$  be the set of first five natural and let  $R$  be a relation on  $A$  defined as follows:  $(x, y) \in R \iff x \leq y$

Express  $R$  and  $R^{-1}$  as sets of ordered pairs. Determine also

(i) the domain of  $R^{-1}$

(ii) The Range of  $R$ .

**Solution:**

$A$  is set of first five natural numbers.

So,  $A = \{1, 2, 3, 4, 5\}$

Given:  $(x, y) \in R \iff x \leq y$

1 is less than 2, 3, 4 and 5.

2 is less than 3, 4 and 5.

3 is less than 4 and 5.

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4 is less than 5.

5 is not less than any number A

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

“An inverse relation is the set of ordered pairs obtained by interchanging the first and second elements of each pair in the original relation. If the graph of a function contains a point (a, b), then the graph of the inverse relation of this function contains the point (b, a)”.

$\therefore R^{-1} = \{(1, 1), (2, 1), (3, 1), (4, 1), (5, 1), (2, 2), (3, 2), (4, 2), (5, 2), (3, 3), (4, 3), (5, 3), (4, 4), (5, 4), (5, 5)\}$

(i) Domain of  $R^{-1} = \{1, 2, 3, 4, 5\}$

(ii) Range of  $R = \{1, 2, 3, 4, 5\}$

4. Find the inverse relation  $R^{-1}$  in each of the following cases:

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

(ii)  $R = \{(x, y) : x, y \in \mathbb{N}; x + 2y = 8\}$

(iii) R is a relation from  $\{11, 12, 13\}$  to  $\{8, 10, 12\}$  defined by  $y = x - 3$

**Solution:**

(i) Given:

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

So,  $R^{-1} = \{(2, 1), (3, 1), (3, 2), (2, 3), (6, 5)\}$

(ii) Given,

$R = \{(x, y) : x, y \in \mathbb{N}; x + 2y = 8\}$

Here,  $x + 2y = 8$

$x = 8 - 2y$

As  $y \in \mathbb{N}$ , Put the values of  $y = 1, 2, 3, \dots$  till  $x \in \mathbb{N}$

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When,  $y = 1$ ,  $x = 8 - 2(1) = 8 - 2 = 6$

When,  $y = 2$ ,  $x = 8 - 2(2) = 8 - 4 = 4$

When,  $y = 3$ ,  $x = 8 - 2(3) = 8 - 6 = 2$

When,  $y = 4$ ,  $x = 8 - 2(4) = 8 - 8 = 0$

Now,  $y$  cannot hold value 4 because  $x = 0$  for  $y = 4$  which is not a natural number.

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

$R^{-1} = \{(3, 2), (2, 4), (1, 6)\}$

(iii) Given,

$R$  is a relation from  $\{11, 12, 13\}$  to  $(8, 10, 12)$  defined by  $y = x - 3$

Here,

$x = \{11, 12, 13\}$  and  $y = (8, 10, 12)$

$y = x - 3$

When,  $x = 11$ ,  $y = 11 - 3 = 8 \in (8, 10, 12)$

When,  $x = 12$ ,  $y = 12 - 3 = 9 \notin (8, 10, 12)$

When,  $x = 13$ ,  $y = 13 - 3 = 10 \in (8, 10, 12)$

$\therefore R = \{(11, 8), (13, 10)\}$

$R^{-1} = \{(8, 11), (10, 13)\}$

5. Write the following relations as the sets of ordered pairs:

(i) A relation  $R$  from the set  $\{2, 3, 4, 5, 6\}$  to the set  $\{1, 2, 3\}$  defined by  $x = 2y$ .

(ii) A relation  $R$  on the set  $\{1, 2, 3, 4, 5, 6, 7\}$  defined by  $(x, y) \in R \Leftrightarrow x$  is relatively prime to  $y$ .

(iii) A relation  $R$  on the set  $\{0, 1, 2, \dots, 10\}$  defined by  $2x + 3y = 12$ .

(iv) A relation  $R$  from a set  $A = \{5, 6, 7, 8\}$  to the set  $B = \{10, 12, 15, 16, 18\}$  defined by  $(x, y) \in R$  if  $x$  divides  $y$ .

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**Solution:**

**(i) A relation R from the set {2, 3, 4, 5, 6} to the set {1, 2, 3} defined by  $x = 2y$ .**

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

**Given,  $x = 2y$  where  $y = \{1, 2, 3\}$**

**When,  $y = 1, x = 2(1) = 2$**

**When,  $y = 2, x = 2(2) = 4$**

**When,  $y = 3, x = 2(3) = 6$**

**$\therefore R = \{(2, 1), (4, 2), (6, 3)\}$**

**(ii) A relation R on the set {1, 2, 3, 4, 5, 6, 7} defined by  $(x, y) \in R \Leftrightarrow x$  is relatively prime to  $y$ .**

**Given:**

**$(x, y) \in R$  if  $x$  is relatively prime to  $y$**

**Here,**

**2 is co-prime to 3, 5 and 7.**

**3 is co-prime to 2, 4, 5 and 7.**

**4 is co-prime to 3, 5 and 7.**

**5 is co-prime to 2, 3, 4, 6 and 7.**

**6 is co-prime to 5 and 7.**

**7 is co-prime to 2, 3, 4, 5 and 6.**

**$\therefore R = \{(2, 3), (2, 5), (2, 7), (3, 2), (3, 4), (3, 5), (3, 7), (4, 3), (4, 5), (4, 7), (5, 2), (5, 3), (5, 4), (5, 6), (5, 7), (6, 5), (6, 7), (7, 2), (7, 3), (7, 4), (7, 5), (7, 6), (7, 7)\}$**

**(iii) A relation R on the set {0, 1, 2, ..., 10} defined by  $2x + 3y = 12$ .**

**Given,**

**$(x, y) \in R$  if  $2x + 3y = 12$**

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Where  $x$  and  $y = \{0, 1, 2, \dots, 10\}$

$$2x + 3y = 12$$

$$2x = 12 - 3y$$

$$x = (12 - 3y)/2$$

When,  $y = 0$ ,  $x = (12 - 3(0))/2 = 12/2 = 6$

When,  $y = 2$ ,  $x = (12 - 3(2))/2 = (12 - 6)/2 = 6/2 = 3$

When,  $y = 4$ ,  $x = (12 - 3(4))/2 = (12 - 12)/2 = 0/2 = 0$

$$\therefore R = \{(0, 4), (3, 2), (6, 0)\}$$

(iv) A relation  $R$  from a set  $A = \{5, 6, 7, 8\}$  to the set  $B = \{10, 12, 15, 16, 18\}$  defined by  $(x, y) \in R \Leftrightarrow x$  divides  $y$ .

Given,

$(x, y) \in R$   $x$  divides  $y$

Where,  $x = \{5, 6, 7, 8\}$  and  $y = \{10, 12, 15, 16, 18\}$

Here,

5 divides 10 and 15.

6 divides 12 and 18.

7 divides none of the value of set  $B$ .

8 divides 16.

$$\therefore R = \{(5, 10), (5, 15), (6, 12), (6, 18), (8, 16)\}$$

6. Let  $R$  be a relation in  $N$  defined by  $(x, y) \in R \Leftrightarrow x + 2y = 8$ . Express  $R$  and  $R^{-1}$  as sets of ordered pairs.

Solution:

Given,

$(x, y) \in R$   $x + 2y = 8$  where  $x \in N$  and  $y \in N$

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$$x + 2y = 8$$

$$x = 8 - 2y$$

Putting the values  $y = 1, 2, 3, \dots$  till  $x \in \mathbb{N}$

$$\text{When, } y = 1, x = 8 - 2(1) = 8 - 2 = 6$$

$$\text{When, } y = 2, x = 8 - 2(2) = 8 - 4 = 4$$

$$\text{When, } y = 3, x = 8 - 2(3) = 8 - 6 = 2$$

$$\text{When, } y = 4, x = 8 - 2(4) = 8 - 8 = 0$$

Now,  $y$  cannot hold value 4 because  $x = 0$  for  $y = 4$  which is not a natural number.

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

$$R^{-1} = \{(3, 2), (2, 4), (1, 6)\}$$

7. Let  $A = \{3, 5\}$  and  $B = \{7, 11\}$ . Let  $R = \{(a, b) : a \in A, b \in B, a-b \text{ is odd}\}$ . Show that  $R$  is an empty relation from  $A$  into  $B$ .

**Solution:**

Given,

$$A = \{3, 5\} \text{ and } B = \{7, 11\}$$

$$R = \{(a, b) : a \in A, b \in B, a-b \text{ is odd}\}$$

On putting  $a = 3$  and  $b = 7$ ,

$$a - b = 3 - 7 = -4 \text{ which is not odd}$$

On putting  $a = 3$  and  $b = 11$ ,

$$a - b = 3 - 11 = -8 \text{ which is not odd}$$

On putting  $a = 5$  and  $b = 7$ :

$$a - b = 5 - 7 = -2 \text{ which is not odd}$$

On putting  $a = 5$  and  $b = 11$ :

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$a - b = 5 - 11 = -6$  which is not odd

$\therefore R = \{ \} = \Phi$

R is an empty relation from A into B.

Hence proved.

8. Let  $A = \{1, 2\}$  and  $B = \{3, 4\}$ . Find the total number of relations from A into B.

Solution:

Given,

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

$n(A) = 2$  (Number of elements in set A).

$n(B) = 2$  (Number of elements in set B).

We know,

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

$$= 2 \times 2$$

$$= 4 \text{ [since, } n(x) = a, n(y) = b. \text{ total number of relations} = 2^{ab}]$$

$\therefore$  Number of relations from A to B are  $2^4 = 16$ .

9. Determine the domain and range of the relation R defined by

(i)  $R = \{(x, x+5) : x \in \{0, 1, 2, 3, 4, 5\}\}$

(ii)  $R = \{(x, x^3) : x \text{ is a prime number less than } 10\}$

Solution:

(i)  $R = \{(x, x+5) : x \in \{0, 1, 2, 3, 4, 5\}\}$

Given,

$R = \{(x, x+5) : x \in \{0, 1, 2, 3, 4, 5\}\}$

$\therefore R = \{(0, 0+5), (1, 1+5), (2, 2+5), (3, 3+5), (4, 4+5), (5, 5+5)\}$

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

So,

$$\text{Domain of relation } R = \{0, 1, 2, 3, 4, 5\}$$

$$\text{Range of relation } R = \{5, 6, 7, 8, 9, 10\}$$

$$(ii) R = \{(x, x^3) : x \text{ is a prime number less than } 10\}$$

Given,

$$R = \{(x, x^3) : x \text{ is a prime number less than } 10\}$$

Prime numbers less than 10 are 2, 3, 5 and 7

$$\therefore R = \{(2, 2^3), (3, 3^3), (5, 5^3), (7, 7^3)\}$$

$$R = \{(2, 8), (3, 27), (5, 125), (7, 343)\}$$

So,

$$\text{Domain of relation } R = \{2, 3, 5, 7\}$$

$$\text{Range of relation } R = \{8, 27, 125, 343\}$$

10. Determine the domain and range of the following relations:

$$(i) R = \{a, b\} : a \in \mathbb{N}, a < 5, b = 4\}$$

$$(ii) S = \{a, b\} : b = |a-1|, a \in \mathbb{Z} \text{ and } |a| \leq 3\}$$

Solution:

$$(i) R = \{a, b\} : a \in \mathbb{N}, a < 5, b = 4\}$$

Given,

$$R = \{a, b\} : a \in \mathbb{N}, a < 5, b = 4\}$$

Natural numbers less than 5 are 1, 2, 3 and 4

$$a = \{1, 2, 3, 4\} \text{ and } b = \{4\}$$

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

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So,

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

Range of relation  $R = \{4\}$

(ii)  $S = \{a, b\}: b = |a-1|, a \in \mathbb{Z} \text{ and } |a| \leq 3\}$

Given,

$S = \{a, b\}: b = |a-1|, a \in \mathbb{Z} \text{ and } |a| \leq 3\}$

$\mathbb{Z}$  denotes integer which can be positive as well as negative

Now,  $|a| \leq 3$  and  $b = |a-1|$

$\therefore a = \{-3, -2, -1, 0, 1, 2, 3\}$

For,  $a = -3, -2, -1, 0, 1, 2, 3$  we get,

$S = \{(-3, |-3-1|), (-2, |-2-1|), (-1, |-1-1|), (0, |0-1|), (1, |1-1|), (2, |2-1|), (3, |3-1|)\}$

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

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

$b = 4, 3, 2, 1, 0, 1, 2$

So,

Domain of relation  $S = \{0, -1, -2, -3, 1, 2, 3\}$

Range of relation  $S = \{0, 1, 2, 3, 4\}$

11. Let  $A = \{a, b\}$ . List all relations on  $A$  and find their number.

Solution:

The total number of relations that can be defined from a set  $A$  to a set  $B$  is the number of possible subsets of  $A \times B$ . If  $n(A) = p$  and  $n(B) = q$ , then  $n(A \times B) = pq$ .

So, the total number of relations is  $2^{pq}$ .

Now,

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

Total number of relations are all possible subsets of  $A \times A$ : $[\{(a, a), (a, b), (b, a), (b, b)\}, \{(a, a), (a, b)\}, \{(a, a), (b, a)\}, \{(a, a), (b, b)\}, \{(a, b), (b, a)\}, \{(a, b), (b, b)\}, \{(b, a), (b, b)\}, \{(a, a), (a, b), (b, a)\}, \{(a, b), (b, a), (b, b)\}, \{(a, a), (b, a), (b, b)\}, \{(a, a), (a, b), (b, b)\}, \{(a, a), (a, b), (b, a), (b, b)\}]$

$$n(A) = 2 \Rightarrow n(A \times A) = 2 \times 2 = 4$$

$$\therefore \text{Total number of relations} = 2^4 = 16$$



# Chapterwise RD Sharma Solutions for Class 11 Maths :

- Chapter 1–Sets
- Chapter 2–Relations
- Chapter 3–Functions
- Chapter 4–Measurement of Angles
- Chapter 5–Trigonometric Functions
- Chapter 6–Graphs of Trigonometric Functions
- Chapter 7–Values of Trigonometric Functions at Sum or Difference of Angles
- Chapter 8–Transformation Formulae
- Chapter 9–Values of Trigonometric Functions at Multiples and Submultiples of an Angle
- Chapter 10–Sine and Cosine Formulae and their Applications
- Chapter 11–Trigonometric Equations
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- Chapter 21–Some Special Series
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- Chapter 23–The Straight Lines
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- Chapter 31–Mathematical Reasoning
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- Chapter 33–Probability

# About RD Sharma

*RD Sharma isn't the kind of author you'd bump into at lit fests. But his bestselling books have helped many CBSE students lose their dread of maths. Sunday Times profiles the tutor turned internet star*

He dreams of algorithms that would give most people nightmares. And, spends every waking hour thinking of ways to explain concepts like 'series solution of linear differential equations'. Meet Dr Ravi Dutt Sharma — mathematics teacher and author of 25 reference books — whose name evokes as much awe as the subject he teaches. And though students have used his thick tomes for the last 31 years to ace the dreaded maths exam, it's only recently that a spoof video turned the tutor into a YouTube star.

R D Sharma had a good laugh but said he shared little with his on-screen persona except for the love for maths. "I like to spend all my time thinking and writing about maths problems. I find it relaxing," he says. When he is not writing books explaining mathematical concepts for classes 6 to 12 and engineering students, Sharma is busy dispensing his duty as vice-principal and head of department of science and humanities at Delhi government's Guru Nanak Dev Institute of Technology.

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