



MATHS

BOOKS - RD SHARMA MATHS (HINGLISH)

RELATIONS

Solved Examples And Exercises

1. Let R be the relation on Z defined by $R = \{(a, b) : a, b \in Z, a - b \text{ is an integer}\}$. Find the domain and range of R .

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2. If $A = \{1, 2, 4\}$, $B = \{2, 4, 5\}$, $C = \{2, 5\}$, then $(A - B) \times (B - C)$ is (a) $\{(1, 2), (1, 5), (2, 5)\}$ (b) $\{(1, 4)\}$ (c) $(1, 4)$ (d) none of these.

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3. If A and B are two sets having 3 elements in common. If $n(A) = 5$, $n(B) = 4$, find $n(A \times B)$ and $n[(A \times B) \cap (B \times A)]$.



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4. If $A = \{1, 3, 5\}$, $B = \{x, y\}$ find the following products $A \times B$ (ii) $B \times A$ (iii) $A \times A$ (iv) $B \times B$



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



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6. Theorem 2 (For any three set $A; B; C$; prove that $A \times (B - C) = (A \times B) - (A \times C)$)



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7. For any three sets A, B, C prove that:

$$A \times (B' \cup C')' = (A \times B) \cap (A \times C) \quad \text{and}$$

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

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8. If $B \subseteq A$, show that $B \times B \subseteq (A \times B) \cap (B \times A)$.

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9. If A and B are any two non-empty sets, then prove that:

$$A \times B = B \times A$$

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10. If $A \subseteq B$, and $C \subseteq D$, prove that $A \times C \subseteq B \times D$.

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11. If $A \subseteq B$, prove that $A \times C \subseteq B \times C$ for any set C .

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12. If R is a relation on the set $A = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$ given by $xRy, x = 3y$, then $R =$

A. $\{(3, 1), (6, 2), (8, 2), (9, 3)\}$

B. $\{(3, 1), (6, 2), (9, 3)\}$

C. $\{(3, 1), (2, 6), (3, 9)\}$

D. none of these

Answer: B

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13. If $A = \{1, 2, 3\}$, $B = \{4, 5, 6\}$, which of the following are relations from $A \rightarrow B$? Give reasons in support of your answer.

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

$\{(4, 2), (4, 3), (5, 1)\}$ (iv) $A \times B$.



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14. $A = \{1, 2, 3, 5\}$ and $B = \{4, 6, 9\}$.

Define a relation R from A to B by $R = \{(x, y) : \text{the difference between } x \text{ and } y \text{ is odd} : x \in A, y \in B\}$. Write R in roster form.



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15. A relation R is defined from $\{2, 3, 4, 5\}$ to $\{3, 6, 7, 10\}$ by : $xRy : x$ is relatively prime to y . Then, domain of R is (a) $\{2, 3, 5\}$ (b) $\{3, 5\}$ (c) $\{2, 3, 4\}$ (d) $\{2, 3, 4, 5\}$.



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16. 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.



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17. The Cartesian product $A \times A$ has 9 elements among which are found $(-1, 0)$ and $(0, 1)$. Find the set A and the remaining elements of $A \times A$.



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18. Let $A = \{-1, 3, 5\}$ and $B = \{2, 3\}$ find the following products (i) $A \times B$ (ii) $B \times A$ (iii) $A \times A$



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19. Express $A = \{(a, b) : 2a + b = 5, a, b \in W\}$ as the set ordered pairs.



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20. If $A \times B = \{(a, 1)(b, 3), (a, 3), (b, 1), (a, 2), (b, 2)\}$, find A and B .



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21. Let $A = \{1, 2, 3\}$ and $B = \{x : x \in N, x \text{ is prime less than } 5\}$. Find $A \times B$ and $B \times A$.



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22. If $A \times B = \{(a, 1)(a, 5), (a, 2), (b, 2), (b, 5), (b, 1)\}$, find $B \times A$.



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23. If $A = \{1, 2\}$, $B = \{3, 4\}$ and $C = \{4, 5, 6\}$ Then,
 $A \times B = \{1, 2\} \times \{3, 4\} = \{(1, 3), (1, 4), (2, 3), (2, 4)\}$



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24. Find x and y , if $(x + 3, 5) = (6, 2x + y)$.



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25. If $A = \{a, b\}$ and $B = \{1, 2, 3\}$, find $A \times B, B \times A$ and $(A \times B) \cap (B \times A)$



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



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27. A relation R is defined from a set $A = \{2, 3, 4, 5\}$ to a set $B = \{3, 6, 7, 10\}$ as follows: $(x, y \in R : x \text{ divides } y)$ Express R as a set of

ordered pairs and determine the domain and range of R



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28. For any sets A, B, C, D prove that:

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



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29. For any three sets A, B, C prove that:

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



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30. Theorem 9(A and B are two non empty set having n element in common ; then prove that $A \times B$ and $B \times A$ have n^2 element in common.)



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31. Let A be a non-empty set such that $A \times B = A \times C$. Show that $B = C$.



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32. Let R be the relation on the set N of natural numbers defined by $R = \{(a, b) : a + 3b = 12, a \in N, b \in N\}$. Find : (i) R (ii) $\text{Dom } R$ (iii) $\text{Ran } R$



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33. If R is the relation "less than" from $A = \{1, 2, 3, 4, 5\}$ to $B = \{1, 4, 5\}$, write down the set of ordered pairs corresponding to R . Find the inverse of R .



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34. A relation R is defined on the set Z of integers as:
 $(x, y) \in R \iff x^2 + y^2 = 25$. Express R and R^{-1} as the sets of ordered pairs
and hence find their respective domains.



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35. For the relation R_1 defined on R by the rule
 $(a, b) \in R_1 : 1 + ab > 0$. Prove that: for
 $(a, b) \in R_1$ and $(b, c) \in R_1$ then $(a, c) \in R_1$ is not true for all $a, b, c \in R$



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36. Find the values of a and b , if $(3a - 2, b + 3) = (2a - 1, 3)$.



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



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38. If $A = \{1, 2, 3\}$, $B = \{3, 4\}$ and $C = \{1, 3, 5\}$, find $A \times (B \cup C)$



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



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



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41. If $A = \{1, 2\}$, from the set $A \times A \times A$



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42. If R is the set of all real numbers, what do the cartesian products $R \times R$ and $R \times R \times R$ represent?



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43. Let A and B be two sets such that $A \times B$ consists of 6 elements. If three elements of $A \times B$ are: $(1, 4), (2, 6), (3, 6)$. Find $A \times B$ and $B \times A$.



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44. Let A and B be two sets such that $n(A) = 5$ and $n(B) = 2$, if a, b, c, d, e are distinct and $(a, 2), (b, 3), (c, 2), (d, 3), (e, 2)$ are in $A \times B$, find A and B .



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45. If $\left(\frac{a}{3} - 1, b - \frac{1}{3}\right) = \left(\frac{5}{3}, \frac{2}{3}\right)$, find the values of a and b .



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46. 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 .



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47. If $(x + 1, 1) = (3, y - 2)$, find the value of x and y .



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



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49. if $A = \{1, 2\}$ and $B = \{1, 3\}$, find $A \times B$ and $B \times A$.



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50. If $A = \{1, 2, 3\}$ and $B = \{3, 4\}$. Find $A \times B$



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51. If $A = \{1, 2, 3\}$ and $B = \{2, 4\}$, find $A \times B$



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52. Let A and B be two sets such that $n(A) = 3$ and $n(B) = 2$. if $(x, 1), (y, 2), (z, 1)$ are $\in A \times B$, find A and B , where x, y, z are distinct elements.



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53. Let $A = \{1, 2, 3, 4\}$ and $R = \{(a, b) : a \in A, b \in A, a \text{ divides } b\}$.

Write R explicitly.



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54. State whether each of the following statements are true or false. If

the statement is false re-write the given statement correctly: (i) If

$p = \{m, n\}$ and $Q = \{n, m\}$, then $P \times Q = \{(m, n), (n, m)\}$ (ii) If A

and B are non empty sets then $A \times B$ is a non empty set of ordered pairs

(x, y) such that $x \in B$ and $y \in A$. (iii) If

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



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55. If $A = \{1, 2\}$, form the set $A \times A \times A$.



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56. If $A = \{1, 2, 4\}$ and $B = \{1, 2, 3\}$, represent following sets - $A \times B$



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57. If $A = \{1, 2, 4\}$ and $B = \{1, 2, 3\}$, represent following sets - $A \times B$



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58. If $A = \{1, 2, 4\}$ and $B = \{1, 2, 3\}$, represent following sets - $A \times A$



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59. If $A = \{1, 2, 4\}$ and $B = \{1, 2, 3\}$, represent following sets - $B \times B$



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



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

Verify that: $A \times C \subset B \times D$



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

Verify that: $A \times (B \cap C) = (A \times B) \cap (A \times C)$



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63. If $A = \{1, 2, 3\}$, $B = \{3, 4\}$, $C = \{4, 5, 6\}$, $f \in d : A \times (B \cap C)$



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64.

If

$$A = \{1, 2, 3\}, B = \{3, 4, 5\}, C = \{4, 6\}, f \in d : (A \times B) \cap (A \times C)$$



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65.

If

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



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66.

If

$$A = \{1, 2, 3\}, B = \{1, 2, 3, 4\}, C = \{4, 5, 6\}, f \in d : (A \times B) \cap (A \times C)$$



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67. If $A = \{a, b, c, d\}$, $B = \{p, q, r, s\}$ then is the following relation from $A \rightarrow B$? Give reasons for your answer.:

$$R_1 = \{(a, p), (b, r), (c, s)\}$$



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68. If $A = \{a, b, c, d\}$, $B = \{p, q, r, s\}$ then Is the following relation from $A \rightarrow B$? Give reasons for your answer.:

$$R_2 = \{(q, b), (c, s), (d, r)\}$$



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69. If $A = \{a, b, c, d\}$, $B = \{p, q, r, s\}$ then Is the following relation from $A \rightarrow B$? Give reasons for your answer.:

$$R_3 = \{(a, p), (a, q), (d, p), (c, r), (b, r)\}$$



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70. If $A = \{a, b, c, d\}$, $B = \{p, q, r, s\}$ then is the following relation from $A \rightarrow B$? Give reasons for your answer.:

$$R_4 = \{(a, p), (q, a), (b, s), (s, b)\}$$



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71. If $A = \{1, 3, 5, 7\}$, $B = \{2, 4, 6, 8, 10\}$ and let $R = \{(1, 8), (3, 6), (5, 2), (1, 4)\}$ be a relation from A to B . Then, find $\text{Domain}(R)$



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72. If R is a relation from set $A = \{2, 4, 5\}$ to set $B = \{1, 2, 3, 4, 6, 8\}$ defined by $xRy \Leftrightarrow x$ divides y . Write R as a set of ordered pairs Find the domain and the range of R .



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73. If $A = \{1, 2, 3\}$, $B = \{4, 5, 6\}$ Is the following relation from $A \rightarrow B$? Give reason in support of your answer:

$$R_1 = \{(1, 4), (1, 5), (1, 6)\}$$



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74. If $A = \{1, 2, 3\}$, $B = \{4, 5, 6\}$ Is the following relation from $A \rightarrow B$? Give reason in support of your answer:

$$R_2 = \{(1, 5), (2, 4), (3, 6)\}$$



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75. If $A = \{1, 2, 3\}$, $B = \{4, 5, 6\}$ Is the following relations from $A \rightarrow B$? Give reason in support of your answer:

$$R_3 = \{(1, 4), (1, 5), (3, 6), (2, 6), (3, 4)\}$$



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76. If $A = \{1, 2, 3\}$, $B = \{4, 5, 6\}$ then, Is the following relation from $A \rightarrow B$? Give reason in support of your answer:

$$R_4 = \{(4, 2), (2, 6), (5, 1), (2, 4)\}$$



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77. Let $A = \{1, 2, 3, 4, 5, 6\}$. Define a relation R on set A by $R = \{(x, y) : y = x + 1\}$ Write down the domain, co domain and range of R .



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78. Figure 2.14 shows a relation R between the sets P and Q . Write this relation R in i. Roster form ii. Set builder form. What is its domain and range?



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79. Let R be a relation in N defined by $R = \{(a, b); a, b \in N \text{ and } a = b^2\}$. Are the following true:

$$(i) (a, a) \in R \quad \forall a \in N$$

$$(ii) (a, b) \in R \Rightarrow (b, a) \in R$$

$$(iii) (a, b) \in R, (b, c) \in R \Rightarrow (a, c) \in R$$



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



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81. Let A be the set of first five natural numbers and let R be a relation on A defined as follows $(x, y) \in R \Leftrightarrow x \leq y$. Express R and R^{-1} as sets of ordered pairs. Determine also The domain of R^{-1} The range of R .



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82. Find the inverse relation R^{-1} in the following case:

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



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83. Find the inverse relation R^{-1} in the following case:

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



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84. If R is a relation on a finite set having n elements, then the number of relations on A is a. 2^n b. $2^n - 2$ c. n^2 d. n^n



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85. Find the inverse relation R^{-1} in the following case: R is a relation from $\{11, 12, 13\} \rightarrow \{8, 10, 12\}$ defined by $y = x - 3$.

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86. Write the following relation as the sets of ordered pair: A relation R on the set $\{1,2,3,4,5,6,7\}$ defined by $(x,y) \in R \Leftrightarrow x$ is $\{1,2,3,4,5,6,7\}$ defined by $(x,y) \in R \Leftrightarrow x$ is relatively prime to y .

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87. Write the following relation as the set of ordered pair: 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 .

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88. Write the following relation as the set of ordered pair: A relation R on the set $\{0, 1, 2, ; 10\}$ defined by $2x + 3y = 12$.

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89. Write the following relation as the set of ordered pair: 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 .



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90. 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 and B .



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



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92. Determine the domain and range of the relation R defined by:

$$R = \{(x, x + 5) : x \in \{10, 1, 2, 3, 4, 5\}\}$$



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93. Determine the domain and range of the relation R defined by:

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



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94. Let $A = \{x, y, z\}$ and $B = \{a, b\}$. Find the total number of relations from A into B .



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95. Let R be a relation from \mathbb{N} to \mathbb{N} defined by $R = \{(a, b) : ab \in \mathbb{N} \text{ and } a = b^2\}$. Are the following true? (i) $(a, a) \in R, \forall a \in \mathbb{N}$ (ii)

$(a, b) \in R, \text{ implies } (b, a) \in R$ (iii) $\forall a,$



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96. Let $A = \{1, 2, 3, 14\}$. Define a relation on a set A by $R = \{(x, y) : 3x - y = 0, \text{ where } x, y \in A\}$. Depict this relationship using an arrow diagram. Write down its domain, co-domain and range.



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97. Define a relation R on the set N of natural numbers by $R = \{(x, y) : y = x + 5, x \text{ is a natural number less than } 4, x, y \in N\}$. Depict this relationship using i. roster form ii. . Write down the domain and range of R .



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98. Let $A = \{1, 2, 3, 5\}$ $B = \{2, 4, 9\}$. Define a relation from A to B by $R = \{(x, y) : x \text{ is odd, } y \text{ is even}\}$. Write it in Roster form



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99. Write the relation $R = \{(x, x^3) : x \text{ is a prime number less than } 10\}$ in roster form.



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100. Let $A = \{1, 2, 3, 4, 5, 6\}$. Let R be a relation on A defined by $R = \{(a, b) : a, b \in A, b \text{ is exactly divisible by } a\}$. Write R in roster form. Find the domain of R . Find the range of R .



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101. Figure 2.15 shows a relationship between the sets P and Q . Write this relation in Set builder form ii. Roster form What is its domain and range?



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102. Let R be the relation on Z defined by $R = \{(a, b) : a, b \in Z, a - b \text{ is an integer}\}$. Find the domain and range of R .



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103. Let R be a relation on $N \times N$ defined by $(a, b) R (c, d) \Leftrightarrow a + d = b + c$ or $all (a, b), (c, d) \in N \times N$ show that:

$$(i) (a, b) R (a, b) \text{ or } all (a, b) \in N \times N$$

$$(ii) (a, b) R (c, d) \Rightarrow (c, d) R (a, b) \text{ or } all (a, b), (c, d) \in N \times N$$

$$(iii) (a, b) R (c, d) \text{ and } (c, d) R (e, f) \Rightarrow (a, b) R (e, f) \quad \text{for all}$$

$$(a, b), (c, d), (e, f) \in N \times N$$



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104. If $A = \{1, 2, 4\}$, $B = \{2, 4, 5\}$ and $C = \{2, 5\}$, write $(A - C) \times (B - C)$.



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105. If $n(A) = 3$, $n(B) = 4$, then write $n(A \times A \times B)$.



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106. If R is a relation defined on the set Z of integers by the rule $(x, y) \in R \Leftrightarrow x^2 + y^2 = 9$, then write domain of R .



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107. If $R = \{(x, y) : x, y \in Z, x^2 + y^2 \leq 4\}$ is a relation defined on the set Z of integers, then write domain of R .

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108. If R is a relation from set $A = \{11, 12, 13\}$ to set $B = \{8, 10, 12\}$ defined by $y = x - 3$, then write R^{-1} .

A. $\{(8, 11), (10, 13)\}$

B. $\{(8, 11), (10, 12)\}$

C. $\{(10, 13), (10, 11)\}$

D. none of these

ANSWER: A

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109. Let $R = \{(x, y) : x, y \in Z, y = 2x - 4\}$. If $(a, -2)$ and $(4, b^2) \in R$, then write the values of a and b .

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110. If $A = \{1, 3, 5\}$ and $B = \{2, 4\}$ list the elements of R , if $R = \{(x, y) : x, y \in A \times B \text{ and } x > y\}$.



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111. If $R = \{(x, y) : x, y \in W, 2x + y = 8\}$., then write the domain and range of R .



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112. Let A and B be two sets such that $n(A) = 3$ and $n(B) = 2$. If $(x, 1)$, $(y, 2)$, $(z, 1)$ are in $A \times B$, write A and B .



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113. If $A = \{1, 2, 3\}$, $B = \{1, 4, 6, 9\}$ and R is a relation from A to B defined by x is greater than y . The range of R is

A. $\{1, 4, 6, 9\}$

B. $\{4, 6, 9\}$

C. $\{1\}$

D. none of these

ANSWER: C



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114. If $R = \{(x, y) : x, y \in Z, x^2 + y^2 \leq 4\}$ is a relation on Z , then domain of R is $\{0, 1, 2\}$ b. $\{0, -1, -2\}$ c. $\{-2, -1, 0, 1, 2\}$ d. none of these



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115. A relation φ from $C \rightarrow R$ is defined by $x\varphi y \Leftrightarrow |x| = y$. Which one is correct? $(2 + 3i)\varphi 13$ b. $3\varphi(-3)$ c. $(1 + i)\varphi 2$ d. $i\varphi 1$



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116. Let R be a relation on N defined by $x + 2y = 8$. The domain of R is
(a) $\{2, 4, 8\}$ b. $\{2, 4, 6, 8\}$ c. $\{2, 4, 6\}$ d. $(1, 2, 3, 4)$



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117. Let R be a relation from a set $A \rightarrow$ a set B , then $R = A \cup B$ b.
 $R = A \cap B$ c. $R \subseteq A \times B$ d. $R \subseteq B \times A$



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118. If R is a relation from a finite set A having m elements to a finite set B having n elements then the number of relations from A to B is
a. 2^{mn} b. $2^{mn} - 1$ c. n^m d. m^n



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1. Let A and B be two sets. Show that the sets $A \times B$ and $B \times A$ have an element in common iff the sets A and B have an element in common.



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2. Prove that: (i) $(A \cup B) \times C = (A \times C) \cup (B \times C)$ (ii)
 $(A \cap B) \times C = (A \times C) \cap (B \times C)$



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3. If $A \times B \subseteq C \times D$ and $A \times B \neq \varnothing$, prove that $A \subseteq C$ and $B \subseteq D$.



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4. Let $A = \{1, 2, 3\}$, $B = \{a, b, c, d\}$ be two sets and let $R = \{(1, a), (1, c), (2, d), (2, c)\}$ be a relation from A to B . Then $R^{-1} = \{(a, 1), (c, 1), (d, 2), (c, 2)\}$ is a relation from B to A .



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5. Let a relation R_1 on the set R of all real numbers be defined as

$(a, b) \in R_1 \Leftrightarrow 1 + ab > 0$ for all $a, b \in R$. Show that:

(i) $(a, a) \in R_1 \forall a \in R$ (ii) $(a, b) \in R_1 \forall a, b \in R$



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6. If $R = \{(2, 1), (4, 7), (1, -2)\}$, then write the linear relation between the components of the ordered pairs of the relation R .



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7. Let $A = \{1, 2, 3\}$, $B = \{1, 3, 5\}$. If relation R from A to B is given by $R = \{(1, 3), (2, 5), (3, 3)\}$. Then R^{-1} is a. $\{(3, 3), (3, 1), (5, 2)\}$ b. c. $\{(1, 3), (5, 2)\}$ d. none of these



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