Exercise 1.1

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

   (*i*) **Relation R in the set A = {1, 2, 3, ..., 13, 14} defined as**
   $$R = \{(x, y) : 3x - y = 0\}$$

   (*ii*) **Relation R in the set N of natural numbers defined as**
   $$R = \{(x, y) : y = x + 5 \text{ and } x < 4\}$$

   (*iii*) **Relation R in the set A = {1, 2, 3, 4, 5, 6} as**
   $$R = \{(x, y) : y \text{ is divisible by } x\}$$

   (*iv*) **Relation R in the set Z of all integers defined as**
   $$R = \{(x, y) : x - y \text{ is an integer}\} \quad (\textit{Important})$$

   (*v*) **Relation R in the set A of human beings in a town at a particular time given by**
   (*a*) **R = {(x, y) : x and y work at the same place}**
   (*b*) **R = {(x, y) : x and y live in the same locality}**
   (*c*) **R = {(x, y) : x is exactly 7 cm taller than y}**
   (*d*) **R = {(x, y) : x is wife of y}**
   (*e*) **R = {(x, y) : x is father of y}**

Sol. (*i*) **Given:** Set A = {1, 2, 3, ..., 13, 14}
   Relation R in the set A is defined as
   $$R = \{(x, y) : 3x - y = 0\}$$
   i.e., $R = \{(x, y) : -y = -3x \text{ i.e., } y = 3x\}$ ...(*i*)
   Is R reflexive? Let $x \in$ A. **Putting** $y = x$ in (*i*), $x = 3x$
   Dividing by $x \neq 0$ ($x \in$ A here is $\neq 0$), $1 = 3$ which is impossible. Therefore $(x, x) \notin$ R and hence R is not reflexive.
   Is R symmetric? Let $(x, y) \in$ R, therefore by (*i*) $y = 3x$
   Interchanging x **and** y **in** (*i*), $x = 3y$ which is not true
   $$\left(\because \quad y = 3x \quad \Rightarrow \quad x = \frac{y}{3} \text{ and } \neq 3y \right)$$
   For example, $2 \in$ A, $6 \in$ A and $6 = 3(2)$ (*i.e.*, $y = 3x$)
   but $2 \neq 3(6) = 18$.
   $\therefore \quad (2, 6) \in$ R but $(6, 2) \notin$ R $\qquad \therefore$ R is not symmetric.
   Is R transitive? Let $(x, y) \in$ R and $(y, z) \in$ R.
   Therefore by (*i*), $y = 3x$ and $z = 3y$.
   To eliminate y, Putting $y = 3x$ in $z = 3y$, $z = 3(3x) = 9x$
   $\therefore$ By (*i*), $(x, z) \notin$ R.
   $\therefore$ R is not transitive.

   (*ii*) **Given:** Relation R in the set of natural numbers defined as

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