



$5(x-y)$

$\sqrt{64}$



$1\frac{7}{10}$

$(-1)^1$



19

Sets

By studying this lesson you will be able to,

- identify the symbols used to denote whether an object is an element of a set or not,
- identify the null set and the symbol used to denote the null set, and
- identify the standard notation used to denote the number of elements in a set.

19.1 Introduction of sets

You learnt in Grade 7 that a set is a collection of identifiable objects. The following are examples of sets.

- (i) The set of all districts in the Southern Province of Sri Lanka.
- (ii) The set of odd numbers between 0 and 10.
- (iii) The set of all the letters in the word 'MATARA'.

You have learnt that the objects belonging to a set are called the elements of that set. Sometimes the word “members” is used instead of the word “elements”.

When we are able to list all the elements, we express the set by writing the elements within curly brackets, separated by commas.

Let A be the set of odd numbers between 0 and 10.

This can be expressed as $A = \{1, 3, 5, 7, 9\}$.

When we write a set using curly brackets, we write each element only once within the curly brackets.

Do the review exercise to recall what you have learnt earlier.



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Review Exercise

- (1) Copy the following expressions in your exercise book. If an expression defines a set, place a \checkmark in front of it. Otherwise place a \times .
- The multiples of 3 between 0 and 20
 - The months of the year
 - Beautiful flowers
 - Prime numbers
 - Tall people
- (2) Each of the following sets are expressed using a common characteristic of its elements. Rewrite each set by listing all its elements within curly brackets.
- $A = \{\text{square numbers between 0 and 20}\}$
 - $B = \{\text{the letters in the word MAHARAGAMA}\}$
 - $C = \{\text{the months with 31 days}\}$
 - $D = \{\text{the digits in the number 41242}\}$
 - $E = \{\text{the provinces of Sri Lanka}\}$
- (3) Let A be the set of all multiples of 2 between 1 and 15.
- Express the set A using a common characteristic of its elements.
 - Write the set A again, listing all its elements within curly brackets.

19.2 Set notation

$$X = \{\text{even numbers between 0 and 10}\}$$

Let us write this set by listing all its elements within curly brackets.

$$X = \{2, 4, 6, 8\}$$

We can write that each of the numbers 2, 4, 6 and 8 is an element of the set X in the following manner by using the symbol " \in " in place of "is an element of".

2 is an element of the set X is written as $2 \in X$.

4 is an element of the set X is written as $4 \in X$.

6 is an element of the set X is written as $6 \in X$.

8 is an element of the set X is written as $8 \in X$.

5 is not an element of the set X .



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We replace “is not an element of” by the symbol \notin and write $5 \notin X$ to express that 5 is not an element of the set X .

Likewise, 7 is not an element of the set X is written as $7 \notin X$.

Example 1

Write, “4 is an element of the set of square numbers” using set notation.



$4 \in \{\text{square numbers}\}$

Example 2

Write, “a parrot is not an element of the set of four legged animals” using set notation.



parrot $\notin \{\text{four legged animals}\}$

Exercise 19.1

- (1) Write each of the following in words as it is read.
 - (i) triangle $\in \{\text{polygons}\}$
 - (ii) $m \notin \{\text{vowels in the English alphabet}\}$
 - (iii) $8 \in \{\text{even numbers}\}$
 - (iv) carrot $\notin \{\text{varieties of fruits}\}$
- (2) Copy the following in your exercise book. Fill in the blanks with \in or \notin as appropriate.
 - (i) 11 $\{\text{prime numbers}\}$
 - (ii) 15 $\{\text{multiples of 4}\}$
 - (iii) blue $\{\text{colours of the rainbow}\}$
 - (iv) mango $\{\text{varieties of fruits}\}$
 - (v) Matara $\{\text{districts in Western Province}\}$
- (3) Copy the following statements in your exercise book. Place a \checkmark in front of the correct statements, and a \times in front of the incorrect statements.
 - (i) $7 \in \{1, 3, 5, 7, 9\}$
 - (ii) $5 \notin \{2, 4, 6, 8\}$
 - (iii) $a \notin \{a, e, i, o, u\}$
 - (iv) $\square \notin \{\triangle, \square, \diamond, \circ\}$
 - (v) $\text{iii} \in \{\text{i, ii, v, iv, vi, vii, x}\}$



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19.3 Number of elements in a set

$A = \{\text{odd numbers between 0 and 10}\}$

Let us express the set A with its elements written within curly brackets.

$A = \{1, 3, 5, 7, 9\}$

A has 5 elements. The notation $n(A)$ is used to denote the number of elements in the set A .

Accordingly, $n(A) = 5$

Example 1

$P = \{\text{multiples of 3 between 1 and 20}\}$. Find the value of $n(P)$.

$P = \{3, 6, 9, 12, 15, 18\}$

$\therefore n(P) = 6$

Example 2

Let P be the set of multiples of 6 between 1 and 20 and Q be the set of even numbers between 1 and 20.

(i) Express each of the sets P and Q with the elements written within curly brackets.

(ii) Copy the following statements and select the ones which are true.

(a) $10 \in P$ (b) $10 \notin Q$ (c) $18 \in P$

(iii) Find $n(P)$ and $n(Q)$.



(i) $P = \{6, 12, 18\}$

$Q = \{2, 4, 6, 8, 10, 12, 14, 16, 18\}$

(ii) (a) 10 is not an element of P .

$\therefore 10 \in P$ is false.

(b) 10 is an element of Q .

$\therefore 10 \notin Q$ is false.

(c) 18 is an element of P .

$\therefore 18 \in P$ is true.

(iii) $n(P) = 3$

$n(Q) = 9$



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**Exercise 19.2**

- (1) (i) Express each of the following sets with its elements written within curly brackets.
- (ii) Write the values of $n(A)$, $n(B)$, $n(X)$, $n(Y)$, $n(P)$, $n(Q)$ and $n(M)$.
- $A = \{\text{counting numbers that are less than } 10\}$
 - $B = \{\text{letters in the word "ANURADHAPURA"}\}$
 - $X = \{\text{days of the week}\}$
 - $Y = \{\text{multiples of } 5 \text{ between } 2 \text{ and } 8\}$
 - $P = \{\text{prime numbers from } 32 \text{ to } 38\}$
 - $Q = \{\text{the grades in primary school in Sri Lanka}\}$
 - $M = \{\text{positive factors of } 30\}$
- (2) Write a set A in terms of a common characteristic of its elements, such that the elements can be identified clearly, where $n(A) = 4$.
- (3) Write a set P in terms of a common characteristic of its elements, such that the elements can be identified clearly, where $n(P) = 1$.

19.4 Null set

$$A = \{\text{even prime numbers between } 5 \text{ and } 15\}$$

Let us consider the elements of this set.

7, 11 and 13 are the prime numbers between 5 and 15. They are not even prime numbers. Accordingly, A does not consist of any elements. A set such as this, which has no elements, is called the **null set**.

Let us consider each set given below.

$$B = \{\text{whole numbers between } 1 \text{ and } 2\}$$

$$C = \{\text{multiples of } 10 \text{ between } 5 \text{ and } 10\}$$

$$D = \{\text{polygons with less than } 3 \text{ sides}\}$$

It is clear that all three sets B , C and D do not have any elements. Therefore, each of them is the null set.

We denote the null set by $\{\}$ or \emptyset .

Therefore, since A is the null set, we write $A = \{\}$ or $A = \emptyset$.

Likewise, we write $B = \{\}$ or $B = \emptyset$.

Therefore we can write $A = B = \emptyset$ or $A = B = \{\}$.



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Note: The number of elements in the null set is zero. That is, $n(\emptyset) = 0$

Exercise 19.3

- (1) Write down whether each of the following sets is the null set or not.
 - (i) $P = \{\text{positive multiples of 5 which are less than 5}\}$
 - (ii) $Q = \{\text{whole numbers from 0 to 10}\}$
 - (iii) $R = \{\text{odd numbers between 1 and 3}\}$
 - (iv) $S = \{\text{digits in the number "41242"}\}$
 - (v) $T = \{\text{colors of the rainbow}\}$
 - (vi) $U = \{0\}$
- (2) Explain with reasons whether the set $\{\text{integers such that the square is } -1\}$ is the null set.

Miscellaneous Exercise

- (1) $M = \{2, 4, 6, 8\}$. Fill in the blanks with \in or \notin as appropriate.

(i) $2 \dots M$	(ii) $4 \dots M$	(iii) $3 \dots M$
(iv) $6 \dots M$	(v) $7 \dots M$	(vi) $8 \dots M$
- (2) Write down three examples for the null set.
- (3) (i) Rewrite each of the following sets by listing the elements within brackets.
 - (ii) Write the values of $n(A)$, $n(B)$, $n(C)$, $n(D)$, $n(E)$ and $n(F)$ for the following sets.
 - (a) $A = \{\text{prime numbers less than 20}\}$
 - (b) $B = \{\text{the letters in the word "university"}\}$
 - (c) $C = \{\text{provinces in Sri lanka}\}$
 - (d) $D = \{\text{square numbers between 20 and 30}\}$
 - (e) $E = \{\text{square numbers which are prime numbers}\}$
 - (f) $F = \{\text{whole numbers between 2 and 16 which are divisible by 3 or 5}\}$
- (4) Write a set P in terms of a common characteristic of its elements, such that the elements can be identified clearly, where $n(P) = 2$.

Summary

- The symbol \in is used to denote that an object belongs to a set.
- The symbol \notin is used to denote that an object does not belong to a set.
- The null set is the set with no element. It is denoted by \emptyset or $\{\}$.
- The notation $n(A)$ is used to denote the number of elements in the set A .