

4.1: Basics of Sets

Learning Objectives

- Define a set using a description, roster form or set-builder notation
- Understand notations used in sets
- Identify a subset of a set

An art collector might own a collection of paintings, while a music lover might keep a collection of CDs. Any collection of items can form a **set**.

Set

A **set** is a collection of distinct objects, called **elements** of the set.

A set can be defined by:

- describing the contents in words
- by listing the elements of the set enclosed in curly brackets (known as the *roster method*)
- by using mathematical symbols to state a rule to determine the elements of the set (known as *set-builder notation*)

Notation

Commonly, we will use a variable to represent a set, to make it easier to refer to that set later. We usually use capital letters to represent the set, and lower case letters for elements of a set.

Symbols used with sets:

- \in means “is an element of”
- $|$ means “such that”
- \mathbb{N} means the set of natural numbers, which is $\{1, 2, 3, 4, \dots\}$
- \emptyset means the **empty set** or $\{\}$, which is a set that contains no elements
 - Note: do not put curly brackets around \emptyset . It is a symbol used to represent the empty set. $\emptyset = \{\}$.

✓ Example 4.1.1

Some examples of sets defined by describing the contents in words:

- a. The set of all even numbers
- b. The set of all books written about travel to Chile

Some examples of sets defined by listing the elements of the set:

- a. $A = \{1, 3, 9, 12\}$
- b. $B = \{\text{red, orange, yellow, green, blue, indigo, violet}\}$

Some examples of sets defined by set-builder notation:

- a. $C = \{x | x \in \mathbb{N} \text{ and } x < 10\}$ (which is $C = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$ in roster form)
- b. $D = \{x | x \text{ is a day of the week that starts with S}\}$ (which is $D = \{\text{Saturday, Sunday}\}$ in roster form)

A set simply specifies the contents; order is not important. The set represented by $\{1, 2, 3\}$ is equivalent to the set $\{3, 1, 2\}$.

✓ Example 4.1.2

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

To notate that 2 is element of the set, we'd write $2 \in A$.

Sometimes a collection might not contain all the elements of a set. For example, Chris owns three Madonna albums. While Chris's collection is a set, we can also say it is a **subset** of the larger set of all Madonna albums.

Subset

A **subset** of a set A is another set that contains only elements from the set A , but may not contain all the elements of A .

If B is a subset of A , we write $B \subseteq A$.

A **proper subset** is a subset that is not identical to the original set – it contains fewer elements.

If B is a proper subset of A , we write $B \subset A$.

Note that the empty set is a subset of every set. Also, every set is a subset of itself.

✓ Example 4.1.3

Consider these three sets:

A = the set of all even numbers $B = \{2, 4, 6\}$ $C = \{2, 3, 4, 6\}$

Here $B \subset A$ since every element of B is an even number, so every element in B is an element of A .

More formally, we could say $B \subset A$ since if $x \in B$, then $x \in A$.

It is also true that $B \subset C$.

C is not a subset of A , since C contains an element, 3, that is not contained in A . It is written $C \not\subseteq A$.

✓ Example 4.1.4

Suppose a set contains the plays “Much Ado About Nothing”, “MacBeth”, and “A Midsummer’s Night Dream”. What is a larger set this might be a subset of?

Solution

There are many possible answers here. One would be the set of plays by Shakespeare. This is also a subset of the set of all plays ever written. It is also a subset of all British literature.

Try it 4.1.1

The set $A = \{1, 3, 5\}$. What is a larger set this might be a subset of?

Answer

There are several answers: The set of all odd numbers less than 10. The set of all odd numbers. The set of all integers. The set of all real numbers.

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