

Operations on sets

Things you need to learn:

The following operations on sets:

- Union of two sets: $A \cup B$;
- Intersection of two sets: $A \cap B$;
- Difference of two sets: $A - B$;
- Complement of a given set: A' .

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Note that the **union** is sometimes also called the **sum** and the **intersection** is sometimes called the **product**.

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- If $A \subseteq B$ and $B \subseteq A$, then $A = B$.

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- If $A \subseteq B$ and $B \subseteq A$, then $A = B$.
- If $A \subseteq B$ and $B \subseteq C$, then $A \subseteq C$.

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You may find this analogous to \leq and $<$ operators.

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If $A = \{1, 2, 3\}$ and $B = \{2, 3, 4\}$, then $A \cup B = \{1, 2, 3, 4\}$

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- If $A \subseteq B$, then $A \cap B = A$;

In particular:

- $\emptyset \cup A = A$;
- $\emptyset \cap A = \emptyset$;

Difference

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A difference $A - B$ of two sets A and B is the set of all elements that belong to A but do not belong to B .

If $A = \{1, 2, 3\}$ and $B = \{2, 3, 4\}$, then $A - B = \{1\}$, but $B - A = \{4\}$

Example 1

Let $A = \{1, 2, 3, 4, 5, 6, 7\}$ and $B = \{2, 4, 6, 8, 10\}$.
Find $A \cup B$, $A \cap B$, $A - B$ and $B - A$.

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$A \cup B$ denotes all elements that are in at least one of A or B , so we have:

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Note: $1 \notin A \cap B$, since 1 does not belong to B . Similarly $8 \notin A \cap B$, since 8 does not belong to A .

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$$A - B = \{1, 3, 5, 7\}$$

Note: $2 \notin A - B$, since 2 belongs to B , so we excluded it. Also $9 \notin A - B$, since 9 wasn't in A in the first place.

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$B - A$ is difference between B and A , it's the set of all elements in B that are not in A . We have:

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Note: $6 \notin B - A$, since 6 is in A , so we excluded it. And $9 \notin B - A$, since 9 wasn't in B .

Complement

Usually in a given problem we have a set U - the universal set, which denotes all elements that are considered for the given problem. Note that we have: $A \subseteq U$ for any set A .

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We can then define the complement of a set A , denoted A' , as all element that are not in A .

Note that $A' = U - A$.

Example 2

Let U be the set of positive integers less than 10 and $A = \{2, 3, 5, 7\}$ and $B = \{2, 4, 6, 8\}$.

Find A' , B' , $A' \cap B'$.

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$$A' = \{1, 4, 6, 8, 9\}$$

Note: $2 \notin A'$, since 2 is an element of A and in A' we want elements that are not in A . On the other hand $12 \notin A'$, since 12 does not belong to our universal set, so we don't even consider it.

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$$B' = \{1, 3, 5, 7, 9\}$$

Note: $2 \notin B'$, since 2 is in B and $12 \notin B'$, since 12 does not belong to the universal set.

Zadanie 2

$A' \cap B'$ is the intersection of A' and B' . We know that:

$$A' = \{1, 4, 6, 8, 9\}$$

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So the intersection of the above sets is:

$$A' \cap B' = \{1, 9\}$$

Exercise 1

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4\}$, $B = \{3, 6, 9\}$ and $C = \{6, 7, 8, 9\}$.

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$$A \cap B = \{3\};$$

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$$A \cap B = \{3\};$$

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Exercise 2

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$$A - C = \{1, 4, 6\};$$

$$B - C = \{4, 6, 8, 10\}$$

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\};$$

$$A - C = \{1, 4, 6\};$$

$$B - C = \{4, 6, 8, 10\}$$

$$A'$$

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\};$$

$$A - C = \{1, 4, 6\};$$

$$B - C = \{4, 6, 8, 10\}$$

$$A' = \{8, 9, 10\};$$

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\};$$

$$A - C = \{1, 4, 6\};$$

$$B - C = \{4, 6, 8, 10\}$$

$$A' = \{8, 9, 10\};$$

$$C'$$

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\};$$

$$A - C = \{1, 4, 6\};$$

$$B - C = \{4, 6, 8, 10\}$$

$$A' = \{8, 9, 10\};$$

$$C' = \{1, 4, 6, 8, 9, 10\};$$

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\};$$

$$A - C = \{1, 4, 6\};$$

$$B - C = \{4, 6, 8, 10\}$$

$$A' = \{8, 9, 10\};$$

$$C' = \{1, 4, 6, 8, 9, 10\};$$

$$A' \cup C'$$

Exercise 2

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$A \cup B = \{1, 2, 3, 4, 5, 6, 7, 8, 10\};$$

$$A - C = \{1, 4, 6\};$$

$$B - C = \{4, 6, 8, 10\}$$

$$A' = \{8, 9, 10\};$$

$$C' = \{1, 4, 6, 8, 9, 10\};$$

$$A' \cup C' = \{1, 4, 6, 8, 9, 10\}$$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)'$$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)' = \{1, 3, 5, 7, 8, 9, 10\};$$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)' = \{1, 3, 5, 7, 8, 9, 10\};$$

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

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)' = \{1, 3, 5, 7, 8, 9, 10\};$$

$$A' \cap (B \cup C) = \{8, 10\};$$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)' = \{1, 3, 5, 7, 8, 9, 10\};$$

$$A' \cap (B \cup C) = \{8, 10\};$$

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

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)' = \{1, 3, 5, 7, 8, 9, 10\};$$

$$A' \cap (B \cup C) = \{8, 10\};$$

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

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)' = \{1, 3, 5, 7, 8, 9, 10\};$$

$$A' \cap (B \cup C) = \{8, 10\};$$

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

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

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)' = \{1, 3, 5, 7, 8, 9, 10\};$$

$$A' \cap (B \cup C) = \{8, 10\};$$

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

$$A - (B \cup C) = \{1\};$$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)' = \{1, 3, 5, 7, 8, 9, 10\};$$

$$A' \cap (B \cup C) = \{8, 10\};$$

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

$$A - (B \cup C) = \{1\};$$

$$C' - B'$$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)' = \{1, 3, 5, 7, 8, 9, 10\};$$

$$A' \cap (B \cup C) = \{8, 10\};$$

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

$$A - (B \cup C) = \{1\};$$

$$C' - B' = \{4, 6, 8, 10\};$$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)' = \{1, 3, 5, 7, 8, 9, 10\};$$

$$A' \cap (B \cup C) = \{8, 10\};$$

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

$$A - (B \cup C) = \{1\};$$

$$C' - B' = \{4, 6, 8, 10\};$$

$$(A' \cup B) - C$$

Exercise 2 ctd.

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $A = \{1, 2, 3, 4, 5, 6, 7\}$,
 $B = \{2, 4, 6, 8, 10\}$ and $C = \{2, 3, 5, 7\}$.

Find:

$$(A \cap B)' = \{1, 3, 5, 7, 8, 9, 10\};$$

$$A' \cap (B \cup C) = \{8, 10\};$$

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

$$A - (B \cup C) = \{1\};$$

$$C' - B' = \{4, 6, 8, 10\};$$

$$(A' \cup B) - C = \{4, 6, 8, 9, 10\}$$

In case of any questions you can email me at T.J.Lechowski@gmail.com.