

## Set Theory Problems

*Short-answer problems about sets.*

**Problem 1** Given two sets  $X$  and  $Y$ , explain what is meant by  $X \cup Y$ .

**Free Response:**  $X \cup Y$  is the set of elements that are in  $X$  or in  $Y$  (or both, as the “or” is inclusive).

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**Problem 2** Given two sets  $X$  and  $Y$ , explain what is meant by  $X \cap Y$ .

**Free Response:**  $X \cap Y$  is the set of elements that are in  $X$  and in  $Y$ .

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**Problem 3** Given two sets  $X$  and  $Y$ , explain what is meant by  $X - Y$ .

**Free Response:**  $X - Y$  is the set of elements that are in  $X$  but not in  $Y$ .

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**Problem 4** Explain the difference between the symbols  $\in$  and  $\subset$ .

**Free Response:** The notation  $X \in Y$  would mean that  $X$  is a single element in the set  $Y$ . In this case,  $X$  might not be a set. The notation  $X \subset Y$  would require that both  $X$  and  $Y$  are sets and also that every element of  $X$  is also in  $Y$ .

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**Problem 5** How is  $\{\emptyset\}$  different from  $\emptyset$ ?

**Free Response:** The empty set,  $\emptyset$ , is a set that contains no elements. The set  $\{\emptyset\}$  contains 1 element that is itself a set.

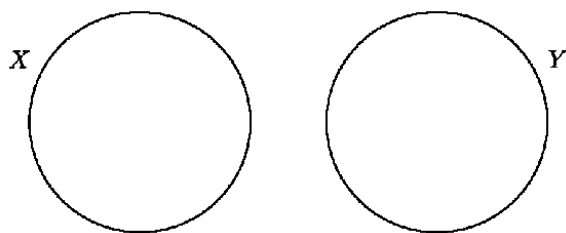
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Learning outcomes:  
Author(s):

**Problem 6** Draw a Venn diagram for the set of elements that are in  $X$  or  $Y$  but not both. How does it differ from the Venn diagram for  $X \cup Y$ ?

**Free Response:** Same as the Venn diagram for  $X \cup Y$ , except that the  $X \cap Y$  part is not shaded.

**Problem 7** If we let  $X$  be the set of “right triangles” and we let  $Y$  be the set of “equilateral triangles” does the picture below show the relationship between these two sets?



Explain your reasoning.

**Free Response:** Yes. The picture is accurate because no right triangles are also equilateral triangles.

**Problem 8** If  $X = \{1, 2, 3, 4, 5\}$  and  $Y = \{3, 4, 5, 6\}$  find:

- (a)  $X \cup Y$
- (b)  $X \cap Y$
- (c)  $X - Y$
- (d)  $Y - X$

**Free Response:** (a)  $X \cup Y = \{1, 2, 3, 4, 5, 6\}$

- (b)  $X \cap Y = \{3, 4, 5\}$
- (c)  $X - Y = \{1, 2\}$
- (d)  $Y - X = \{6\}$

**Problem 9** If  $X \cup Y = X$ , what can we say about the relationship between the sets  $X$  and  $Y$ ? Explain your reasoning.

**Free Response:**  $Y \subset X$  because every element of  $Y$  must already be in  $X$ .

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**Problem 10** If  $X \cap Y = X$ , what can we say about the relationship between the sets  $X$  and  $Y$ ? Explain your reasoning.

**Free Response:**  $X \subset Y$  because every element of  $X$  must already be in  $Y$ .

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**Problem 11** If  $X - Y = \emptyset$ , what can we say about the relationship between the sets  $X$  and  $Y$ ? Explain your reasoning.

**Free Response:**  $X \subset Y$  because that would mean  $X$  contains no elements that are not also in  $Y$ , which implies that  $X$  is a subset of  $Y$ .

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