Worksheet: Operations on Sets

This worksheet covers operations on sets, including complements, relative complements, unions, intersections, symmetric differences and Cartesian products. You could read the study guide: Basics of Sets, to help you with the language and notation of sets.

1. You are given the following sets:

   - **U**, the set of natural numbers less than 17 (the universe);
   - **A**, the set of multiples of 4 less than 17;
   - **B**, the set of all even numbers less than 17, and;
   - **C**, the set of prime numbers less than 17.

   a) Write out these sets using proper set notation, and draw them all on a single Venn diagram.

   b) Work out the following operations on **A**, **B**, **C**, writing your answer in set notation. Remember that you should perform operations in brackets first.

   
   i) \( A^c \)  
   ii) \( B \cup C \)  
   iii) \( A \cap C \)  
   iv) \( B \setminus C \)  
   v) \( C \setminus B \)  
   vi) \( C \oplus B \)  
   vii) \( B \cap (C^c) \)  
   viii) \( A \cup (B \cup C) \)  
   ix) \( A \cup (B \cap C) \)  
   x) \( (B^c) \cap C \)  
   xi) \( (A \oplus B) \cup C \)  
   xii) \( (A \cup B) \setminus (B \cup C) \)

2. You are given the two sets \( X = \{1,2,3,4\} \) and \( Y = \{1,2,3,4,5\} \).

   a) Write down all elements of \( V = X \times Y \).

   You are given two more sets \( D = \{(1,d) : d \in Y\} \) and \( E = \{(e,3),(f,4) : e,f \in X\} \).
b) Write down all elements of $D$ and $E$ and draw these sets in a Venn diagram with universe set $V$.

c) Work out the following operations on $D$ and $E$, writing your answer in proper set notation.

i) $D^c$ ii) $E^c$ iii) $D \cup E$ iv) $D \cap E$

v) $D \setminus E$ vi) $E \setminus D$ vii) $D \oplus E$ viii) $D \times D$

3. You are given the following sets:

- $W = \{w: \text{w is a positive whole number less than 20}\}$ (the universe set);
- $F = \{1, 4, 6, 8, 9, 10, 16\}$;
- $G = \{2, 3, 4, 8, 9, 10, 11, 14, 16\}$, and;
- $H = \{1, 3, 5, 7, 9, 10, 11, 12, 19\}$.

a) Work out the following sets, writing your answer in correct set notation. Draw a Venn diagram for each of your answers.

i) $F \cup (G \cap H)$ ii) $(F \cup G) \cap (F \cup H)$ iii) $(G \cap H)^c$ iv) $G^c \cap H^c$

v) $H \cap (G \cup F)$ vi) $(H \cap G) \cup (F \cap H)$ vii) $(G \cap F)^c$ viii) $F^c \cup G^c$

b) Do you notice anything about your answers? Write down your observations.

c) Remember the sets $U$, $A$, $B$, and $C$ from Question 1. With $U$ in place of $W$, $A$ in place of $F$, $B$ in place of $G$ and $C$ in place of $H$, work out Question 3 a) i)-viii) once more. Do these answers agree or disagree with your observation in part b)?