Addition and Subtraction of Whole Numbers

Whole numbers answer the question “How many objects are there in a set?”

Set Model of Addition for Whole Numbers

- Recall that two sets are disjoint if they have no elements in common, i.e.
  
  \[ A \cap B = \emptyset. \]

- **addition** Suppose \( a \) and \( b \) are whole numbers. If \( A \) and \( B \) are disjoint sets so that \( n(A) = a \) and \( n(B) = b \) then the sum of \( a \) and \( b \), written as \( a + b \) is given by
  
  \[ a + b = n(A \cup B). \]

- Example: Combining a box of ten crayons and a box of five crayons gives 15 crayons.

- Physical Models: Blocks.

Measurement Model of Addition for Whole Numbers

- Number line representation: numbers are distances from zero.

Properties of Addition for Whole Numbers

- Closure property: If \( a \) and \( b \) are whole numbers then \( a + b \) is also a whole number.

- Commutative property: \( a + b = b + a \)

- Associative property: \( (a + b) + c = a + (b + c) \)

- Additive identity property: \( a + 0 = a \)

- Properties can be illustrated with any of the models from section 2.2.

Subtraction for Whole Numbers

- If \( a \) and \( b \) are whole numbers then the difference of \( a \) and \( b \), written \( a - b \), is the unique number \( c \) such that \( a = b + c \).

- Take away model: Start with \( a \) objects take away \( b \) objects and determine how many are left.

- Missing addend model: Start with a collection of \( b \) objects. How many more objects are needed to get to \( a \) objects?
• Comparison model: Start with a collection of \(a\) objects and a collection of \(b\) objects. How many more objects are in the collection of \(a\) objects?

• Number line model. Draw \(a\) and \(b\) on the number line. Find the distance between \(a\) and \(b\).

   (Remember to always write positive numbers with right pointing arrows!)

**More problems with Venn-diagrams.** Use Venn diagrams to solve the following problems:

• There are 150 senators on the student senate and there are three optional committees: Greek life (G), academic affairs (A), and social life (S). There are 30 senators on \(G\), 50 on \(A\), and 40 on \(S\). Also, 10 senators are on \(A \cap G\), 10 are on \(A \cap S\), 15 are on \(S \cap G\). There are 5 senators on all three committees. How many senators did not volunteer for any committees? Answer: 60

• There are 25 people at the ice cream social. 15 have chocolate; 15 have vanilla, 10 have strawberry; 10 have both chocolate and vanilla; 5 have both chocolate and strawberry; 5 have both strawberry and vanilla; 3 people have all three. How many people have no ice-cream? Answer: 25 - 23 = 2