Section 3.1: Whole Numbers Addition & Subtraction

ADDITION: addend + addend = sum

- Set Model:

Addition of Whole Numbers: Let a and b be any two whole numbers. If A and B are disjoint sets with $a = n(A)$ and $b = n(B)$, then $a + b = n(A \cup B)$.

- Measurement Model: Addition can be represented by directed arrows.

PROPERTIES OF WHOLE NUMBER ADDITION

- **Closure Property:** The sum of any two whole numbers is a whole number.

  Example 1: Determine if the following sets are closed under addition.

  (a) $\{0, 1, 2\}$

  (b) $\{0, 2, 4, 6, 8, 10, \ldots\}$

- **Commutative Property:** Let a and b be whole numbers. Then

$$a + b = b + a.$$

- **Associative Property:** Let a, b, and c be any whole numbers. Then

$$(a + b) + c = a + (b + c).$$

- **Identity Property:** There is a unique whole number 0 such that for all whole numbers a,

$$a + 0 = a = 0 + a.$$

  Zero is called the **additive identity**.

Example 2: Identify the property being used.

(a) $3 + 7 = 7 + 3$

(b) $(4 + 9) + 3 = 4 + (9 + 3)$

(c) $8 + 0 = 8$

(d) $5 + (6 + 7) = (6 + 7) + 5$

SUBTRACTION: minuend − subtrahend = difference

- **Take-Away Approach:**

Subtraction of Whole Numbers (take-away): Let a and b be any whole number and let A and B be sets such that $a = n(A)$ and $b = n(B)$ and $B \subseteq A$. Then $a - b = n(A - B)$.

- **Missing Addend Approach:**

Subtraction of Whole Numbers (missing addend): Let a and b be any whole numbers. Then $a - b = c$ if and only if $a = b + c$ for some whole number c. We call c the missing addend.

NOTE: Subtraction does not satisfy any of the properties that addition satisfied.