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

(c) 8+0=8

- (b) (4+9)+3=4+(9+3)
- (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.