

## 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:  $25 - 23 = 2$