Vectors and Scalars

- Many quantities in physics, like velocity, have a ***magnitude and a direction***. Such quantities are called ***VECTORS***.
  - Other quantities which are vectors: acceleration, force, ...
- Many quantities in physics, like speed, have a ***magnitude only***. Such quantities are called ***SCALARS***.
  - Other quantities which are scalars: temperature, mass, volume, ...

Vector & Scalar Quantities

- ***Vector*** ≡ Quantity with **magnitude & direction.**
- ***Scalar*** ≡ Quantity with **magnitude only.**

Equality of Two Vectors

- Consider 2 vectors, **A** & **B**

A = B means **A** & **B** have the same **magnitude & direction.**

Graphical Method of Adding Vectors

"Recipe"

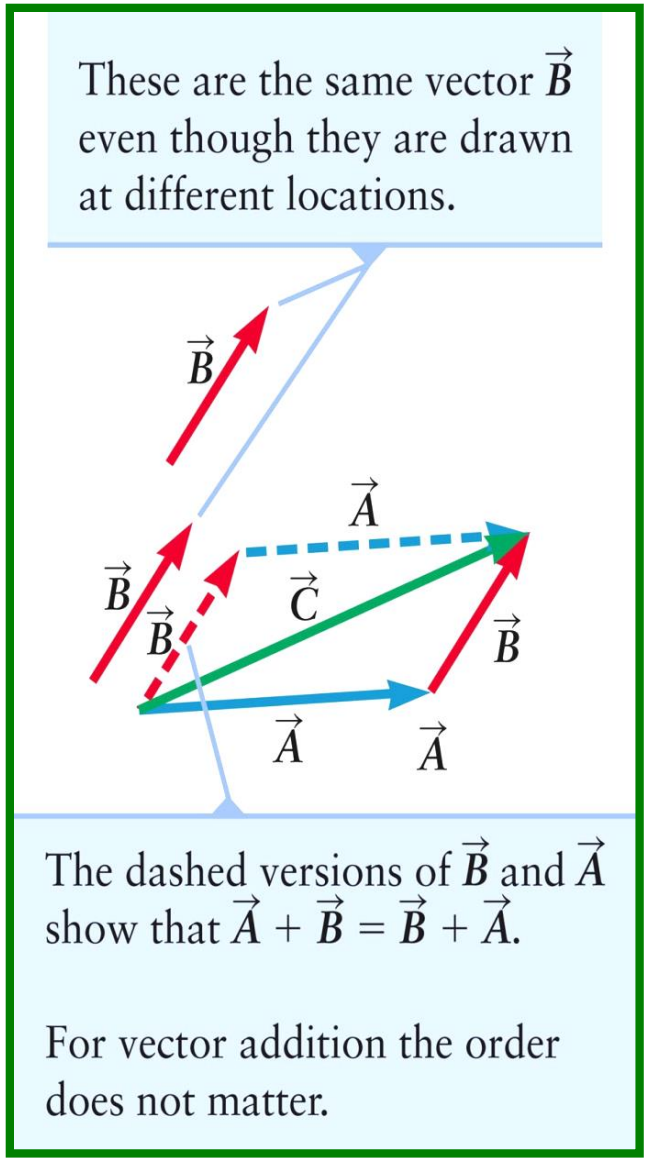
- Draw the 1st vector.
- Draw the 2nd vector

starting at the tip of the first vector

- Continue to draw vectors "tip-to-tail"
- The sum is drawn from the tail of the first vector to the tip of the last vector

Example:

$$\overline{A} + \overline{B} = \overline{C}$$

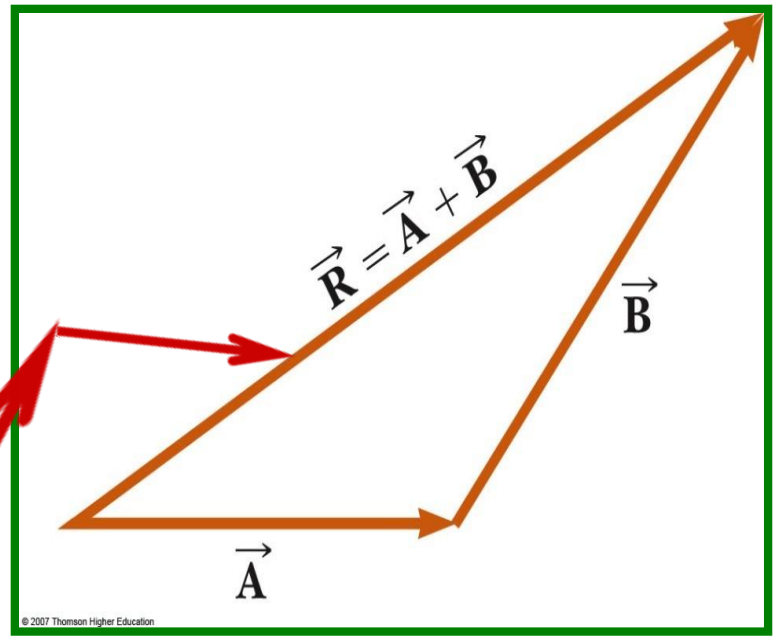


"Tail to Tip" Method.

Consider **R = A + B** (See figure!).

Graphical Addition Recipe

1. Draw **A** & **B** to scale.
2. Place the tail of **B** at the tip of **A**
3. Draw an arrow from the tail of **A** to the tip of **B**



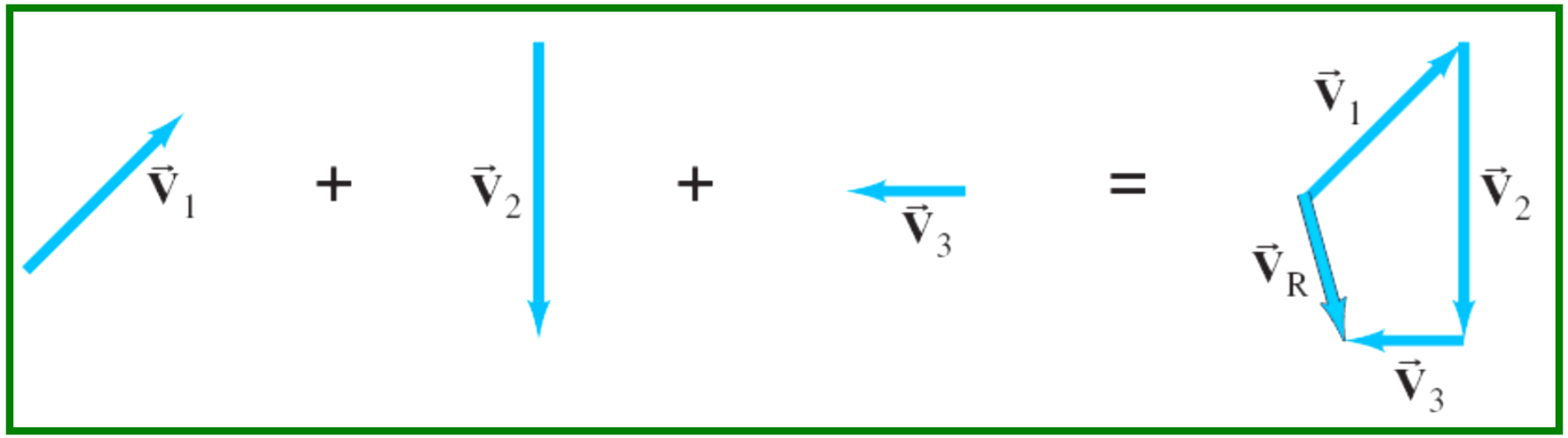
4. ***This arrow is the Resultant R***

Measure its length & angle with the **x**-axis.

Graphical Method of Vector Addition

- Adding (3 or more) vectors:

$$\mathbf{V} = \mathbf{V}_1 + \mathbf{V}_2 + \mathbf{V}_3$$



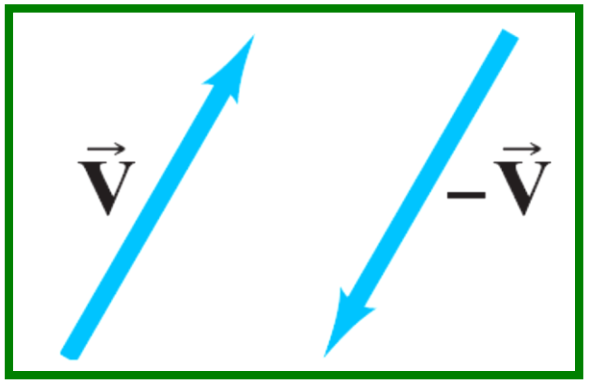
- Even if the vectors are not at right angles, they can be added graphically with the tail-to-tip method.

Subtraction of Vectors

- First, ***Define The Negative of a Vector*:**

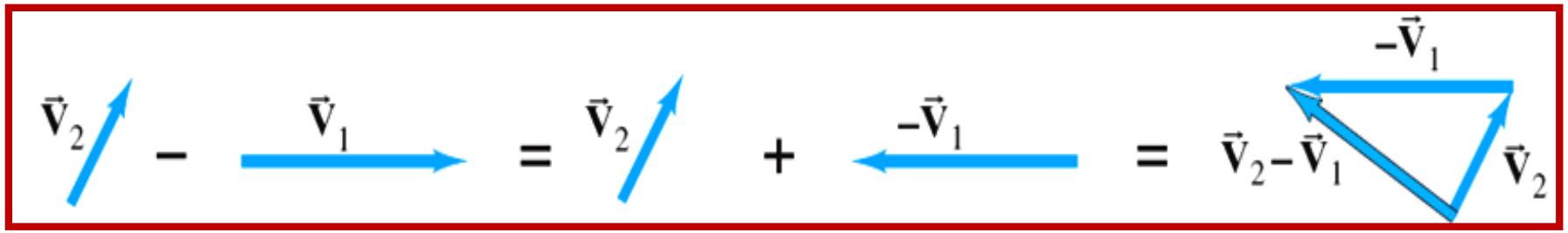
  - V ≡ vector with the same magnitude (size) as **V** but with opposite direction.

  Math: V + (- V) ≡ 0



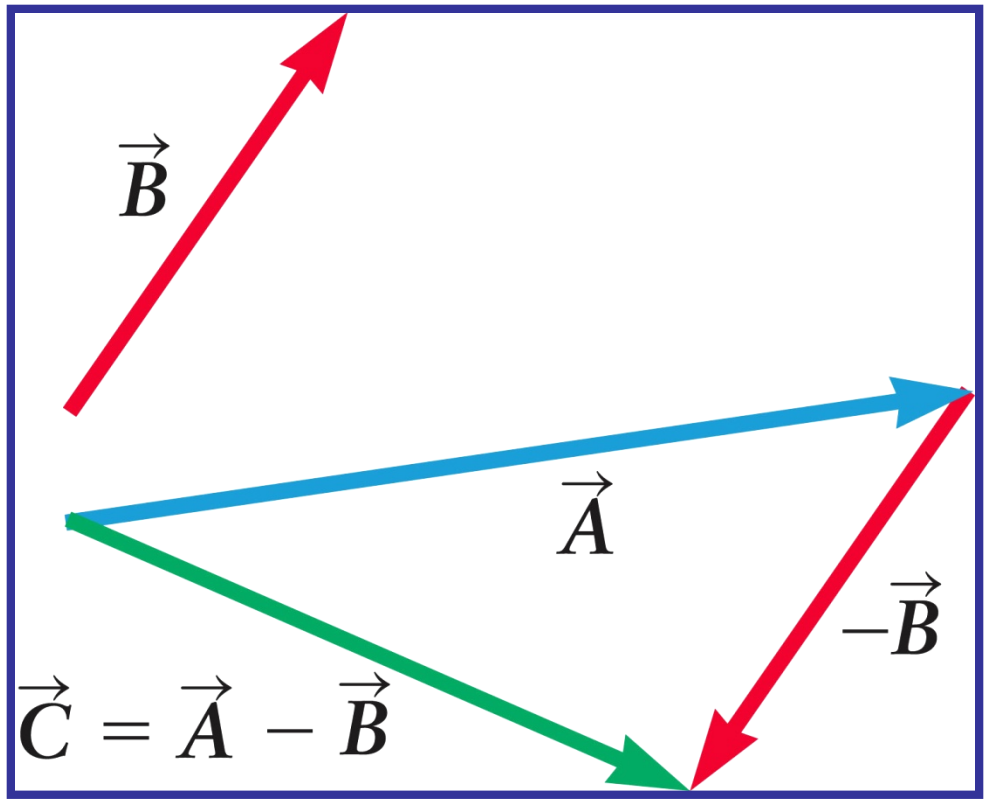
- Then add the negative vector.
- For 2 vectors, **V_1 & V_2:**

$$\vec{V}_2 - \vec{V}_1 = \vec{V}_2 + (-\vec{V}_1).$$



Subtracting Vectors

- To subtract one vector from another, add the first vector to the negative of the 2nd vector, as in the figure below:



Multiplication by a Scalar

- A vector **V** can be multiplied by a scalar **c**

$$\mathbf{V' = cV}$$

V' ≡ vector with magnitude **cV** & same direction as **V.**

- If **c** is negative, the resultant is in the opposite direction.