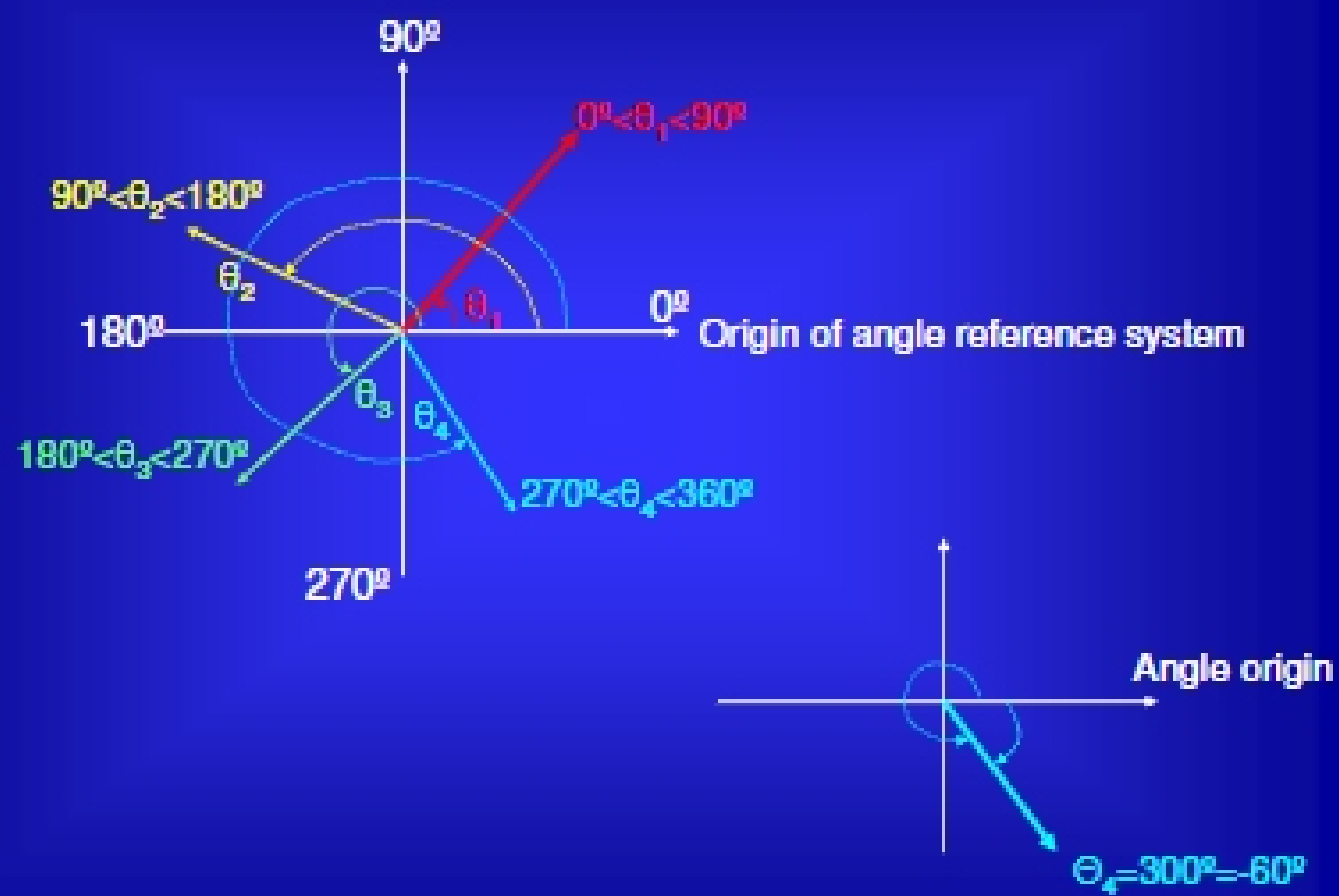


## Chapter 3 - Vectors

- I. Definition
- II. Arithmetic operations involving vectors
  - A) Addition and subtraction
    - Graphical method
    - Analytical method  $\rightarrow$  Vector components
  - B) Multiplication

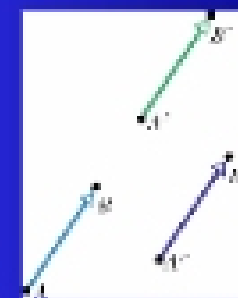
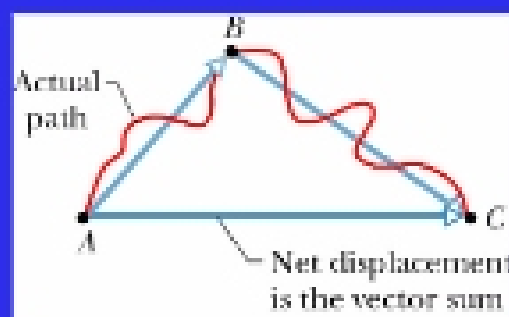
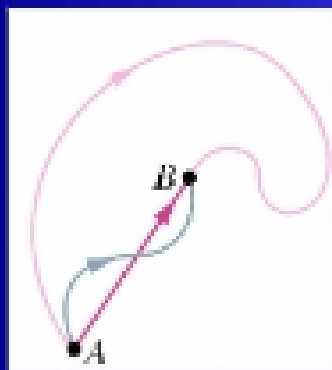
### Review of angle reference system



## I. Definition

**Vector quantity:** quantity with a magnitude and a direction. It can be represented by a vector.

**Examples:** displacement, velocity, acceleration.



Same displacement

Displacement → does not describe the object's path.

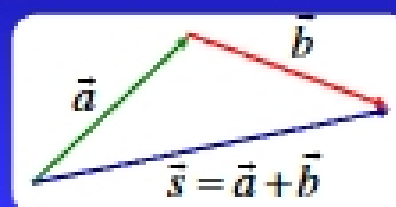
**Scalar quantity:** quantity with magnitude, no direction.

**Examples:** temperature, pressure

## II. Arithmetic operations involving vectors

**Vector addition:**  $\vec{s} = \vec{a} + \vec{b}$

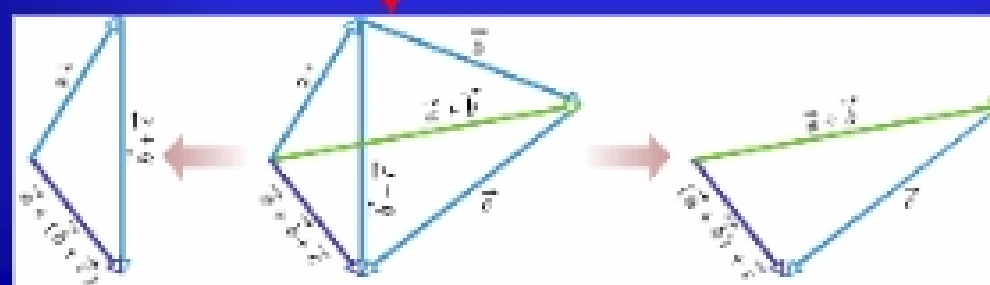
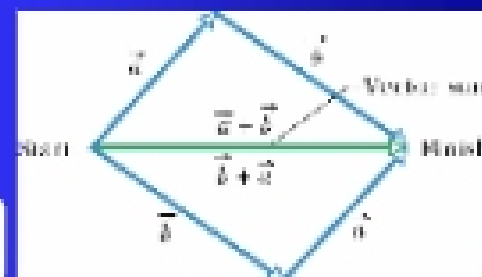
- **Geometrical method**



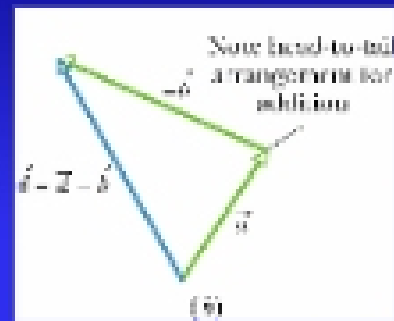
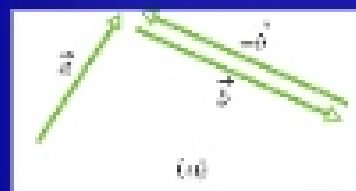
**Rules:**

$$\vec{a} + \vec{b} = \vec{b} + \vec{a} \quad (\text{commutative law}) \quad (3.1)$$

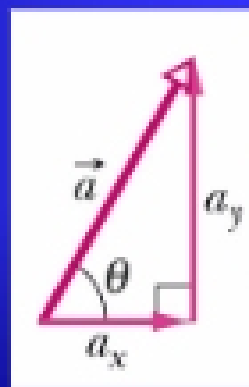
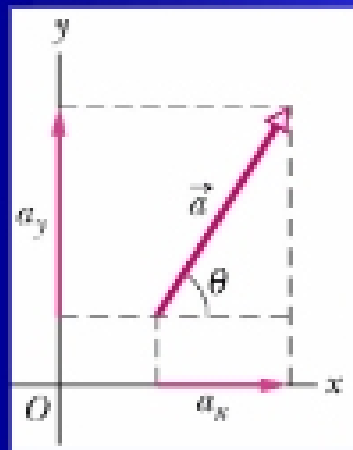
$$(\vec{a} + \vec{b}) + \vec{c} = \vec{a} + (\vec{b} + \vec{c}) \quad (\text{associative law}) \quad (3.2)$$



**Vector subtraction:**  $\vec{d} = \vec{a} - \vec{b} = \vec{a} + (-\vec{b})$  (3.3)



**Vector component:** projection of the vector on an axis.



$$a_x = a \cos \theta$$

$$a_y = a \sin \theta$$

(3.4)

Scalar components of  $\vec{a}$

$$a = \sqrt{a_x^2 + a_y^2}$$

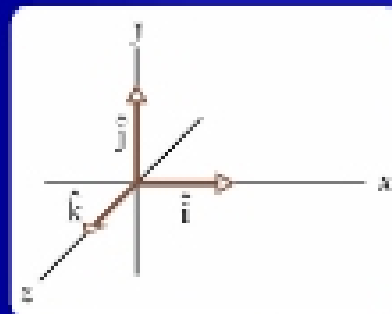
(3.5)

Vector magnitude

$$\tan \theta = \frac{a_y}{a_x}$$

Vector direction

**Unit vector:** Vector with magnitude 1.  
No dimensions, no units.

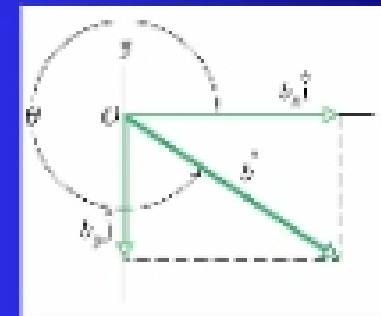
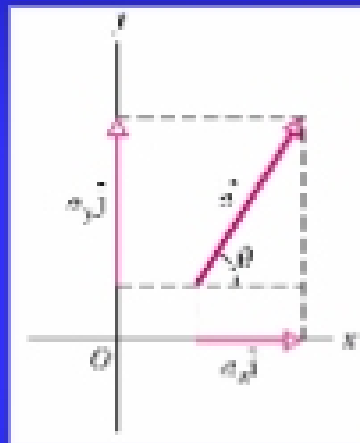


$\hat{i}, \hat{j}, \hat{k} \rightarrow$  unit vectors in positive direction of  $x, y, z$  axes

$$\vec{a} = a_x \hat{i} + a_y \hat{j}$$

(3.6)

Vector component



**Vector addition:**

- **Analytical method:** adding vectors by components.

$$\vec{r} = \vec{a} + \vec{b} = (a_x + b_x)\hat{i} + (a_y + b_y)\hat{j}$$
 (3.7)