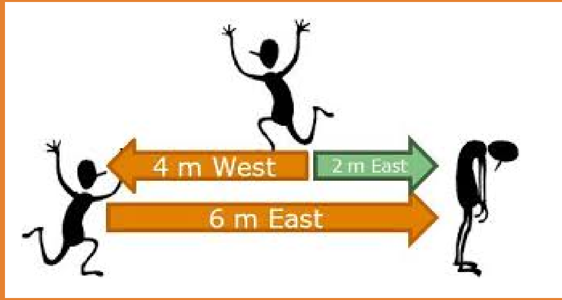


Vector & Scalar Quantities

Meghdadi **Fall 2016**

Scalar

1. **value**
2. **Appropriate units**

Ex. Mass: 5kg
Temp: 21° C
Speed: 65 mph

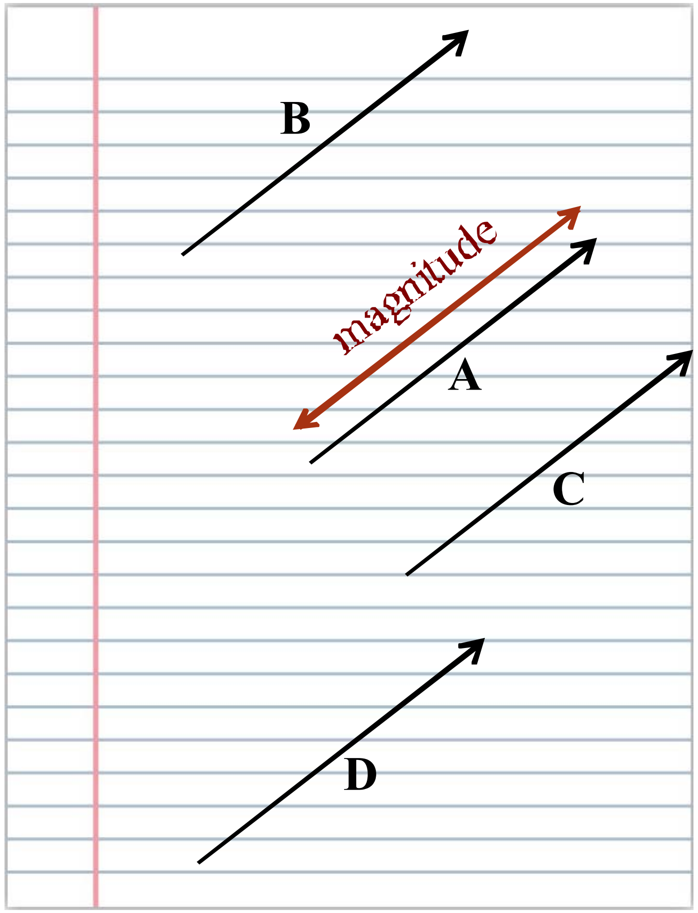
Vector

1. **value**
2. **Appropriate units**
3. **direction**

Ex.
Acceleration:
9.8 m/s^2 down
Velocity:
25 mph West

More about Vectors

A vector is represented on paper by an arrow.

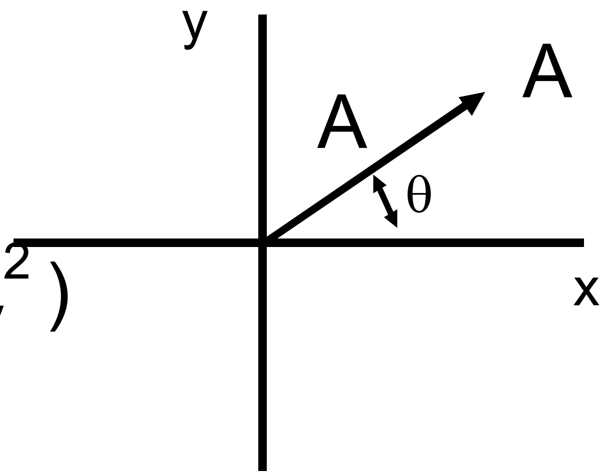


The length represents magnitude.

A vector can be “picked up” and moved on the paper as long as the length and direction its pointing does <u>not</u> change.

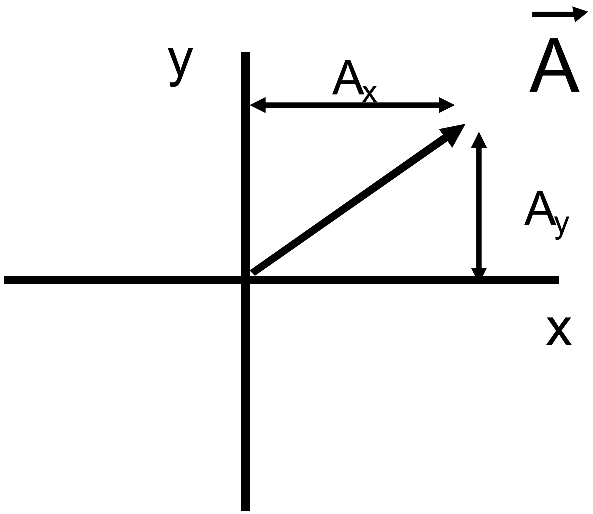
$\vec{A}=\vec{B}=\vec{C}=\vec{D}$

Two ways to specify a vector:



It is either given by

- a magnitude A $=\sqrt{(A_x^2 + A_y^2)}$
- and a direction $\theta = \tan^{-1} A_y/A_x$



Or it is given in the x and y components as

- $A_x = A \cos\theta$
- $A_y = A \sin\theta$

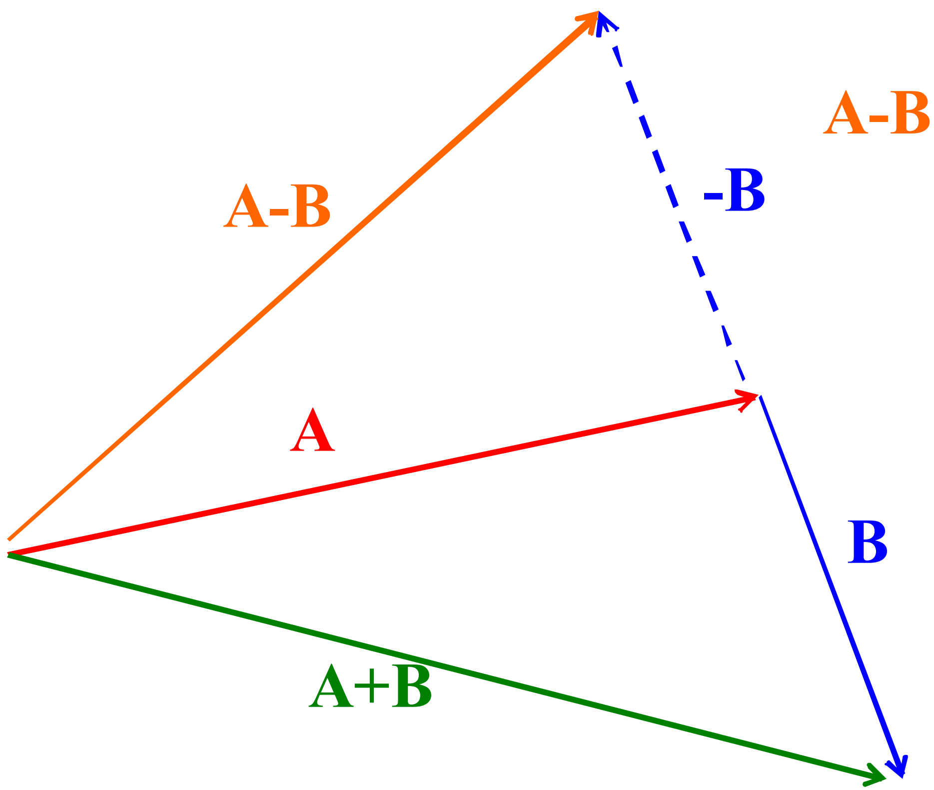
Vector Addition:

A=(10,2)

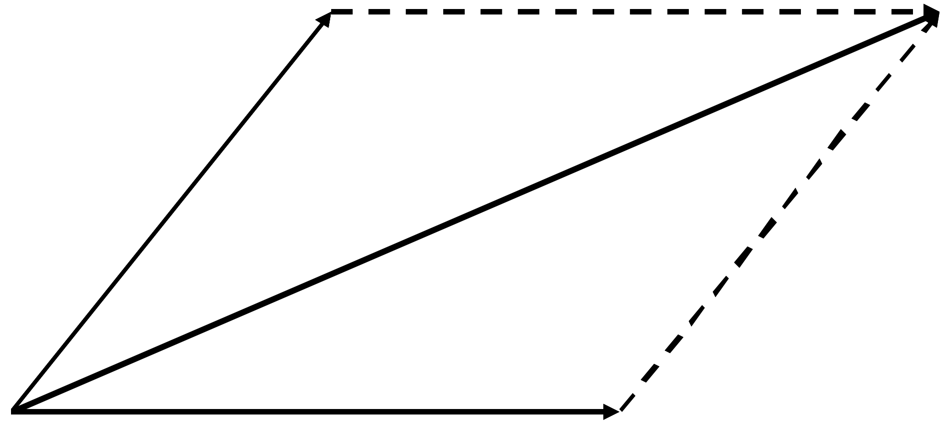
B=(2,-5)

A+B = (10+2,2-5)
= (12 ,-3)

A-B = A + (-B)
= (10-2 , 2+5)
= (8 , 7)



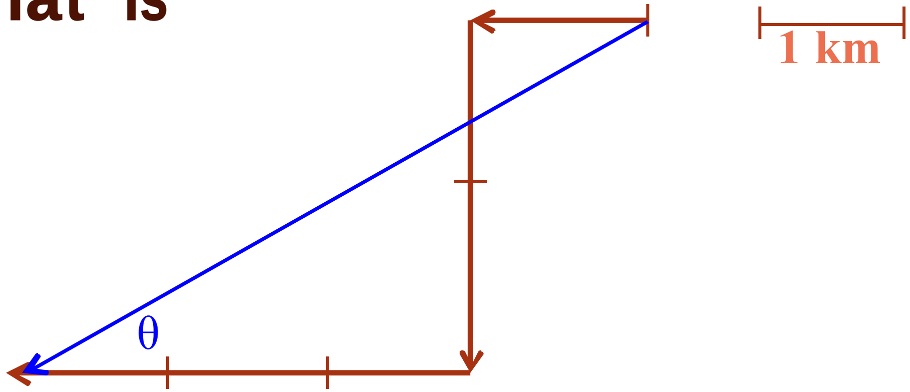
Parallelogram method of addition (tailtotail)



The magnitude of the resultant depends on the relative directions of the vectors

EX.1.

A hiker walks *1 km west*, then *2 km south*, then *3 km west*. What is the sum of his distance traveled? What is his displacement?



Traveled distance = 1+2+3 = 6 km

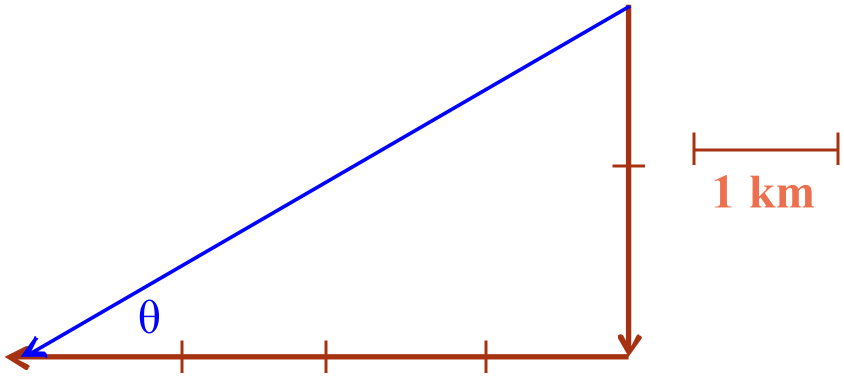
Displacement = | (-1,0) + (0,-2) + (-3,0) | , $\theta = \tan^{-1} 1/2$

= |(-4,-2)|

= $\sqrt{20}$

Ex.2.

Another hiker walks *2 km south* and *4 km west*. What is the sum of her distance traveled using a graphical representation? How does it compare to hiker #1?



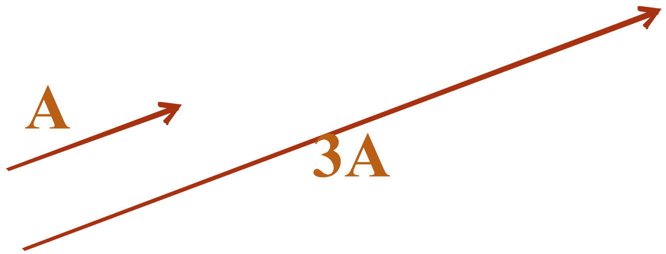
Traveled distance = 2 + 4 = 6 km

Displacement $= |(0,-2) + (-4,0)|$, $\theta = \tan^{-1} 1/2$

$= |(-4,-2)|$

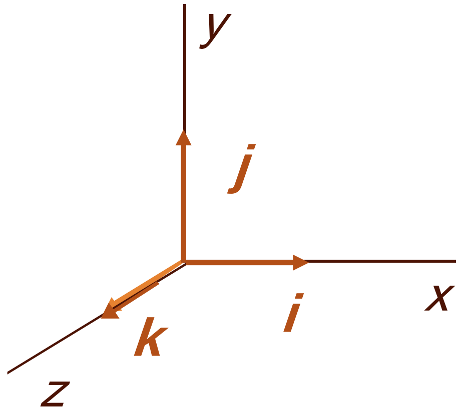
$= \sqrt{20}$

Multiplication of a Vector by Scalar



$$A = (X_A , Y_A)$$

$$\alpha A = (\alpha X_A , \alpha Y_A)$$



Unit Vectors

Unit vectors are dimensionless
and
their magnitude is equal to 1

Cartesian unit vectors:

$\hat{i}$: a unit vector pointing in the x direction

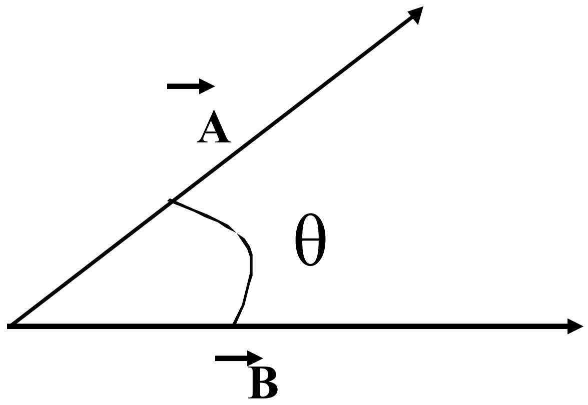
$\hat{j}$:a unit vector pointing in the y direction

$\hat{k}$: a unit vector pointing in the z direction

$$|\hat{i}| = |\hat{j}| = |\hat{k}| = 1$$

Dot product (scalar) of two vectors:

$$\vec{A} \cdot \vec{B} = |\vec{A}|\,|\vec{B}| \cos\theta$$

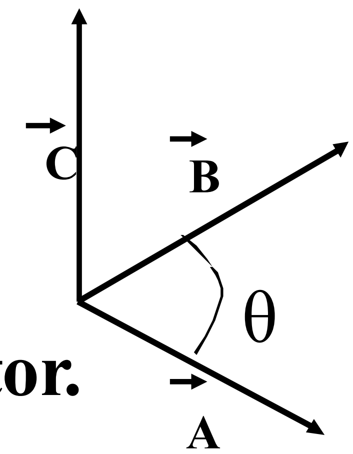


$$\vec{A} . \vec{B} = \vec{B} . \vec{A}$$

$$= \mathbf{A_x B_x + A_y B_y + A_z B_z}$$

Cross product(vector)of two vectors

$$|\vec{C}| = |\vec{A} \times \vec{B}| = |\vec{A}|\,|\vec{B}| \sin\theta$$



1. **the vector product creates a new vector.**
2. **this vector is normal to the plane defined by the original vectors and its direction is found by using the right hand rule**