Classroom change from coming Monday

Monday(1:00-2:25): 314 Faculty Memorial Hall

Thursday(10:00-11:25): 111 Tiernan Hall

http://geocities.com/kenahn7/

Common exam #1: 8:30am on Feb. 9th(Fri.) at 205 Kupfrian Hall

HW#2 due tomorrow (Feb. 2)

Today in this class…

Example and Problems for Chapter 2

Chapter 3. Vectors

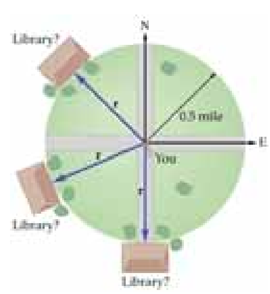
Chapter 3. Vectors

Vectors and scalars

Component of vectors and unit vectors

Adding and multiplying vectors

Observations: Vectors & Scalars



You also need to know the direction in which you should walk to the library!

A library is located 0.5 mi from you. Can you point where exactly it is?

Vectors: Described by the number, units and direction!

Scalars: Described by the number and units only.

Vectors in 1D, 2D, 3D

- In 1-Dimension particle can move only in + or – direction
- In 2 or 3 dimensions things are more interesting
- Must include direction (angles instead of a sign)

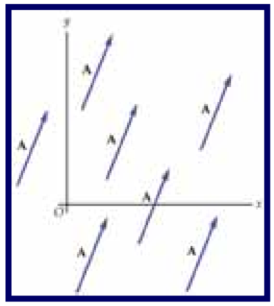
Vector and Scalar Quantities

- Vectors
  - Displacement
  - Velocity (magnitude and direction!)
  - Acceleration
  - Force (any force, such as the gravitational force, magnetic force, etc…)
- Scalars:
  - Distance
  - Speed (magnitude of velocity)
  - Magnitude of acceleration
  - Magnitude of force
  - Mass
  - Energy

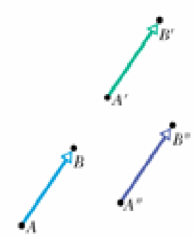
To describe a vector we need more information than to describe a scalar! Therefore vectors are more complex!

Important Notation

- To **describe vectors** we will use:
  - The bold font: Vector A is **A**
  - Or an **arrow** above the vector: $\vec{A}$
  - In the pictures, we will always show vectors as arrows
  - All vectors with the same **magnitude and directions are identical**, even though they might be at different locations
  - To describe the magnitude of a vector we will use absolute value sign: $|\vec{A}|$ or just A
- To **describe scalars** we will use regular font: 5 m/s (speed), 60 km (distance)…

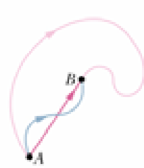


Shifted Vectors



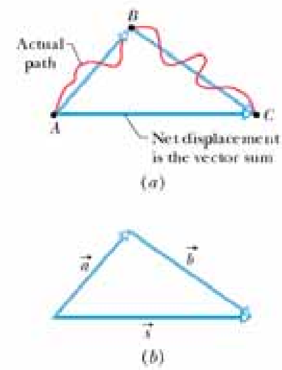
(a)

Displacement Vector

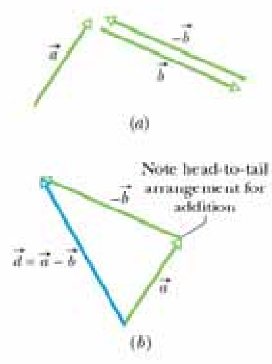


(b)

Adding vectors geometrically

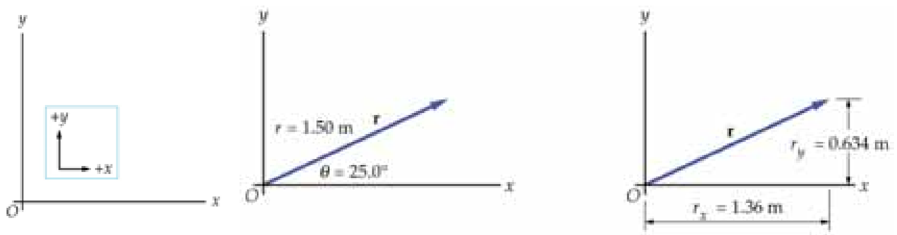


Subtracting vectors geometrically



Describing Vectors

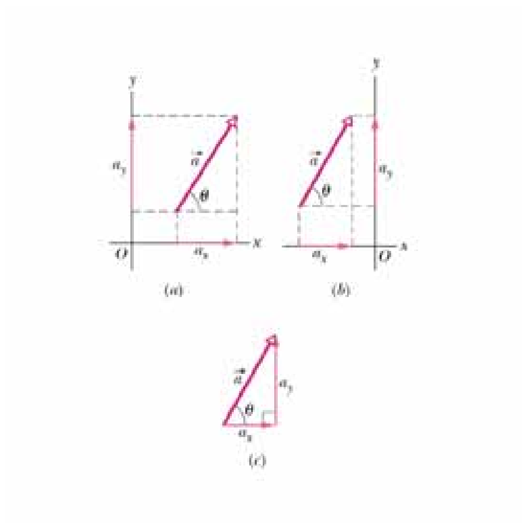
Vectors: Described by the number, units and direction!



Vectors: Can be described by their magnitude (always positive) and direction. For example: Your displacement is 1.5 m at an angle of 25^0.

Can be described by components. For example: Your displacement is *1.36 m* in the positive x direction and *0.634 m* in the positive y direction.

Vector Components: Algebraic Description



$$\sin\theta = \frac{\text{leg opposite } \theta}{\text{hypotenuse}}$$

$$\cos\theta = \frac{\text{leg adjacent to } \theta}{\text{hypotenuse}}$$

$$\tan\theta = \frac{\text{leg opposite } \theta}{\text{leg adjacent to } \theta}$$

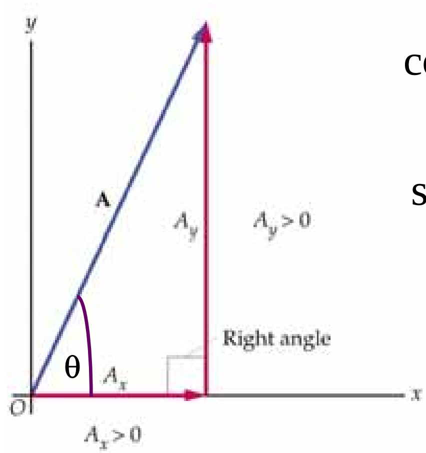
Two units for angle : degree(°) and radian

$$360^0 = 2\pi \text{ radian}$$

When using a calculator, check the unit setting for angle.

Vector Components: Algebraic Description

Vectors: Described by the number, units and direction!

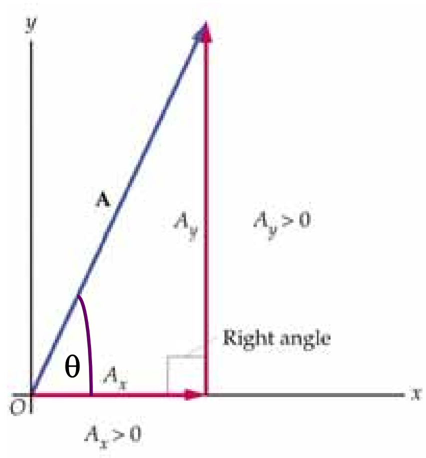


$$\cos\theta = \frac{A_x}{A} \rightarrow A_x = A\cos\theta$$

$$\sin\theta = \frac{A_y}{A} \rightarrow A_y = A\sin\theta$$

Vector Components: Algebraic Description

Vectors: **Described by the number, units and direction!**



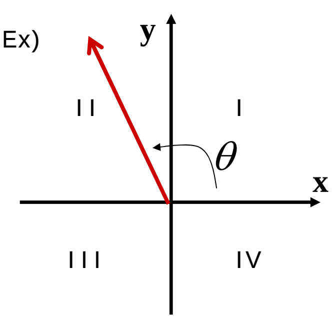
$$\begin{cases} A_x = A\cos(\theta) \\ A_y = A\sin(\theta) \end{cases}$$

$$\begin{cases} |\vec{A}| = \sqrt{(A_x)^2 + (A_y)^2} \\ \tan(\theta) = \dfrac{A_y}{A_x} \end{cases}$$

Or, $\theta = \tan^{-1}\left(\dfrac{A_y}{A_x}\right)$

Check that quadrant is correct when taking inverse trig. functions

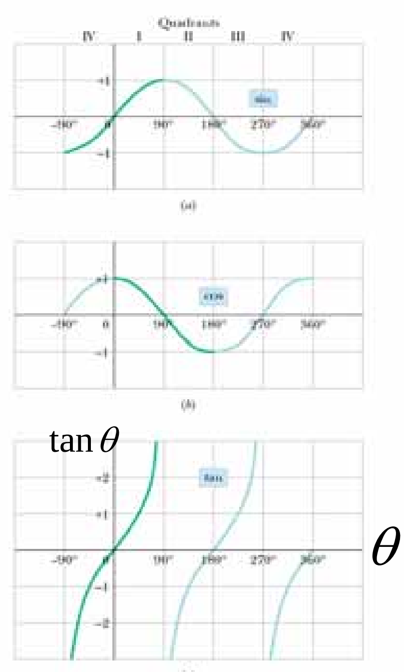
Ex)



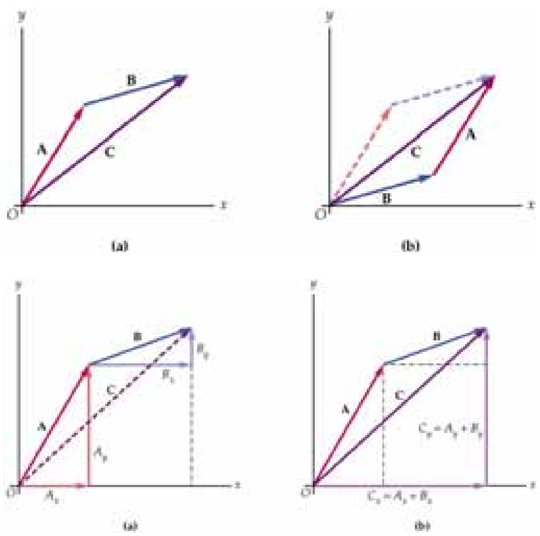
$A_x = -1,\ A_y = 3$

$\tan^{-1}\left(\dfrac{3}{-1}\right) = -72^o \neq \theta$

$\theta = -72^o + 180^o = 108^o$



Operations with Vectors: Addition



COMMENTS:

To add vectors geometrically, use head-to tail rule:

C = A + B = B + A.

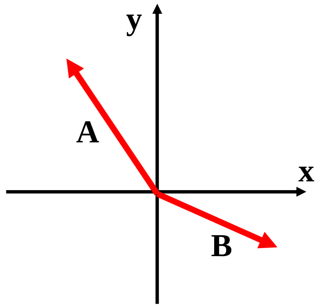
To add vectors algebraically, add corresponding components and then find the magnitude and direction of the resultant vector

Example : Operations with Vectors

Vector **A** is described algebraically as **(-3, 5),** while vector **B** is **(4, -2).** Find the value of **magnitude** and **direction** of the sum (**C**) of the vectors **A** and **B**.

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

$$\begin{cases} C_x = A_x + B_x \\ C_y = A_y + B_y \end{cases} \text{and} \begin{cases} C^2 = (C_x)^2 + (C_y)^2 \\ \tan(\theta) = \dfrac{C_y}{C_x} \end{cases}$$



Sample Problem 3-2 in HR&W

A small airplane leaves an airport on an overcast day and is later sighted 215 km away in a direction making an angle 22° east of due north. How far east and north is the airplane when sighted?

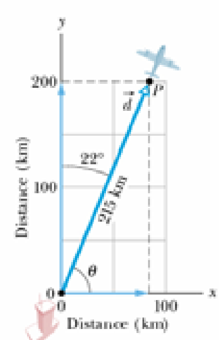
Approach

1. Draw Diagram using data

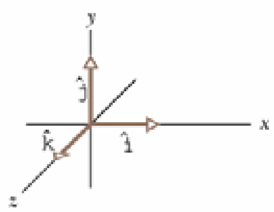
2. Find components

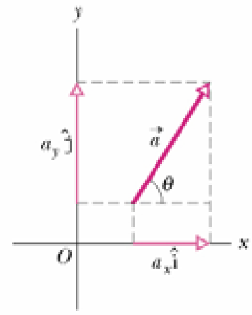
Find d_x

Find d_y



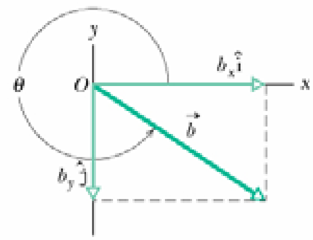
Unit vectors





(a)

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



(b)

Sample Problem 3-4 in HR&W

Find the magnitude and direction of the vector resulting from combining the following vectors?

$$\vec{a} = (4.2m)\hat{i} - (1.5m)\hat{j}$$

$$\vec{b} = (-1.6m)\hat{i} + (2.9m)\hat{j}$$

$$\vec{c} = (-3.7m)\hat{j}$$

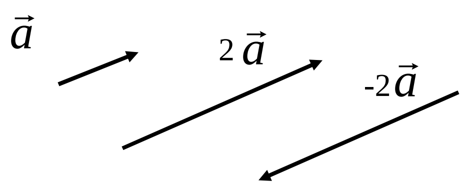
Scalar &Vector Multiplication

$s\,\vec{a}$ is

a vector with a magnitude $|s|\cdot|\vec{a}|$ and

a direction : same as $\vec{a}$, if s is positive

opposite $\vec{a}$, if s is negative

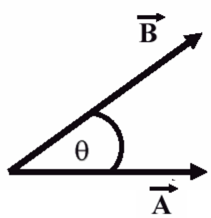


Vector & vector Multiplication

Definition of "Scalar" product

$$\vec{A} \bullet \vec{B} = AB\cos\theta = A_x B_x + A_y B_y + A_z B_z$$: Scalar

θ is the angle between the vectors if you put their tails together



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

since $\cos(\theta) = \cos(-\theta)$

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