PHYS2010 LECTURE 5 * Lab next week! Do prelab.

Moving on to 2 dimensions. Need to introduce a new mathematical concept: VECTOR: Quantity with magnitude (size) and direction.

Think how velocity (in 1D) differs from speed. Speed tells only how fast you're going, but velocity tells you which direction as well. [In 1D, there are only two directions (left & right, or fwd & backward, or + and −).] Velocity is therefore a VECTOR.

In 2D, represent vector by an arrow:

$\vec{A}$

length of arrow = magnitude of vector
pointing direction = direction of vector

Vectors in physics: displacement (position), velocity, acceleration

Notation: Handwritten vector: $\vec{A}$

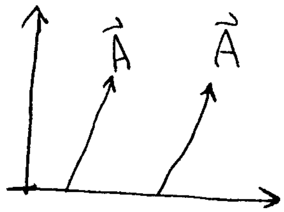
Printed vector: **A** boldface, <u>not</u> italic

(Note — your text goes all-out and writes $\vec{\mathbf{A}}$)

Magnitude: A (italic, <u>not</u> bold, no arrow) or $|\vec{A}|$

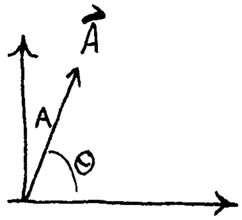
Note that vector magnitude is never negative.
(can be zero)

Vector does not specify its location:



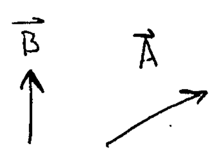
Same magnitude, direction = same vector.
(But "position vectors" are understood relative to a specific origin

In 2D, need 2 numbers to specify a vector:

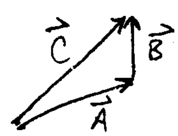


Magnitude A, direction angle θ (always counterclockwise, usually from x axis)

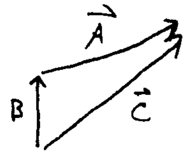
Vectors can be added:



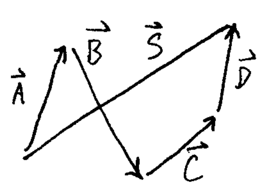
"tail-to-head" method



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

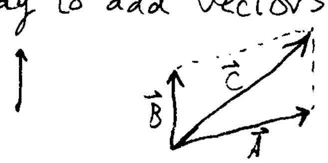


$\vec{A} + \vec{B} = \vec{B} + \vec{A}$ addition is commutative



$\vec{S} = \vec{A} + \vec{B} + \vec{C} + \vec{D}$
(Something like a treasure map: "20 steps north, 12 east, ...")

Another way to add vectors: parallelogram method.



$\vec{C} = \vec{A} + \vec{B}$ same result as tail-to-head.

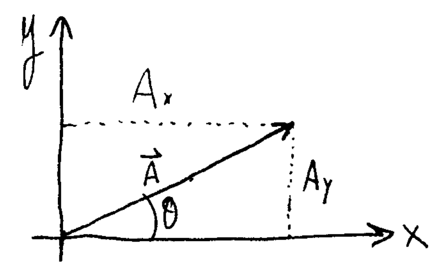
Can multiply a vector by a scalar (number):

- Magnitude is multiplied: $|3\vec{A}| = 3A$
- Direction is unaffected if scalar positive, reversed if scalar negative:

Negative of a vector: same magnitude, opposite direction.

Subtracting vectors = adding negative: $\vec{A}-\vec{B} = \vec{A}+(-\vec{B})$

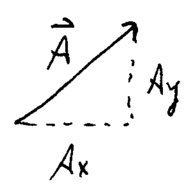
Components of a vector: "projections" of the vector on perpendicular axes: sort of like shadows.



$A_x = A\cos\theta$ = x-component of $\vec{A}$

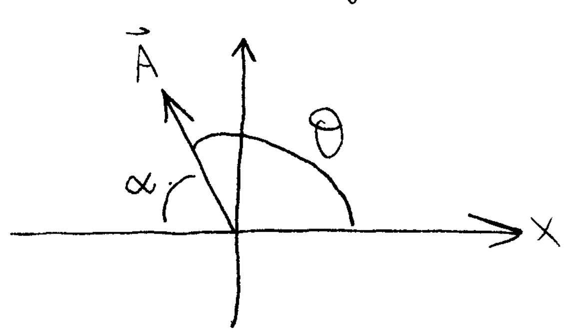
$A_y = A\sin\theta$ = y-component of $\vec{A}$

These make a right triangle:



so $|\vec{A}| = \sqrt{A_x^2 + A_y^2}$

What if vector is pointing down or to left?



$A_x = \cos\theta < 0$

Can also write as $A_x = -\cos\alpha$, which is often easier to calculate.

A_x, A_y or A, θ are equivalent ways to specify $\vec{A}$.