

## Announcements 23 Feb 08

- Homework #4
  - Written homework due on Friday
  - Online homework due on Tue Mar 3
- Exam 1 tomorrow from 7 to 9 pm

– Location depends on the first letter of your last name:

A through C	HAS 124
D through H	HAS 126
I through R	MORRILL 1N329
S through Z	HAS 134

- Help session today 3 – 5 pm in Goessman 64
- SI session tomorrow 5 – 7 pm in 10<sup>th</sup> floor DuBois library



## Chapter 3 Vectors and Motion in Two Dimensions

Topics:

- Vectors, coordinate systems, and components
- Projectile motion
- ~~Circular motion~~

Sample question:

The archer fish shoots a stream of water droplets at an insect. What determines the path that the droplets take through the air?



**Velocity** is a rate of change in position:

Velocity  $v_x = \frac{\Delta x}{\Delta t}$

**Acceleration** represents a rate of change in velocity:

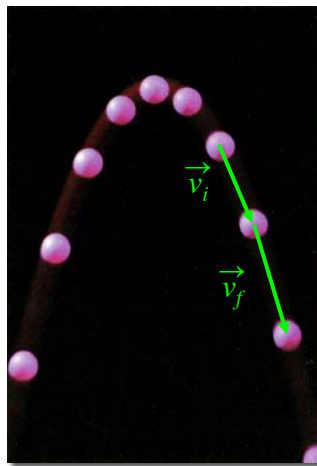
Acceleration  $a_x = \frac{\Delta v_x}{\Delta t}$

In general, both of these are **vectors**.

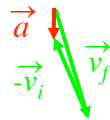
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What direction is the acceleration of a ball in free fall?



**acceleration**  
$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$
  
Given by the change in velocity per time.




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# Vector Representation

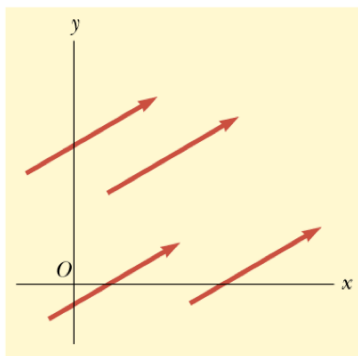
## Four ways of representing a vector

1. As an arrow 
2. As a letter capped by arrow  $\vec{A}$
3. As a **boldface** letter **A**
4. As a set of coordinates  $(A_x, A_y)$

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### VECTORS



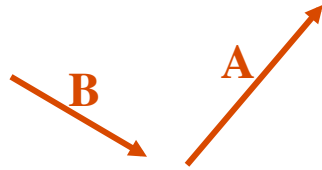
The above vectors are ALL equal to each other.

- Vectors are equal IF, and *ONLY* IF, they have the same magnitude and direction (and represent the same quantity).
- It does not matter that they are drawn at different places.

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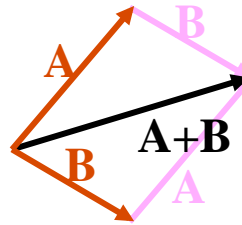
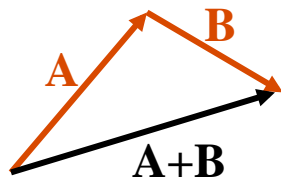
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## Adding Vectors



You can slide vectors around in the plane, as long as you do not change their magnitude or direction.

To **ADD** vectors use tip-to-tail method:



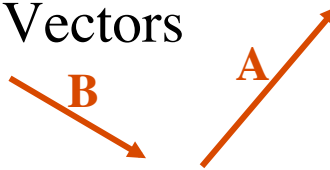
$$A+B=B+A$$

You can add in any order.

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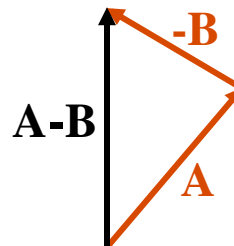
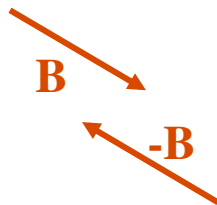
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## Subtracting Vectors



To **SUBTRACT** a vector add its negative:

$$A - B = A + (-B)$$

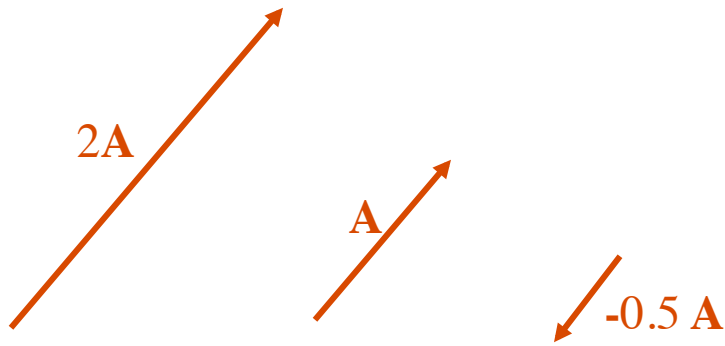


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# Multiplying by a scalar

## Multiplying a vector by a scalar number

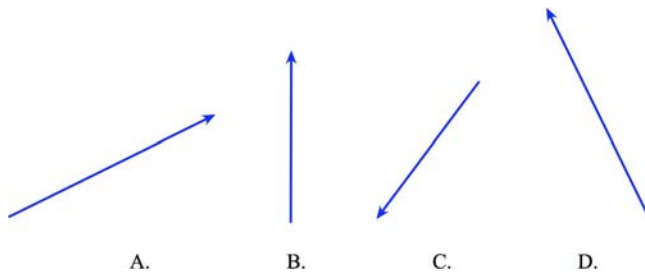
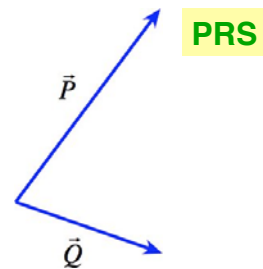


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## Vector Addition Question

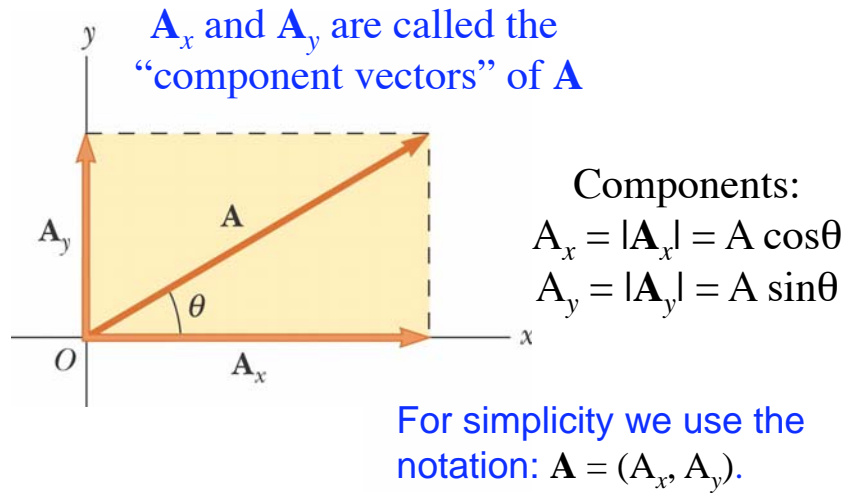
Which of the vectors below best represents the vector sum  $2\vec{Q} + \vec{P}$ ?



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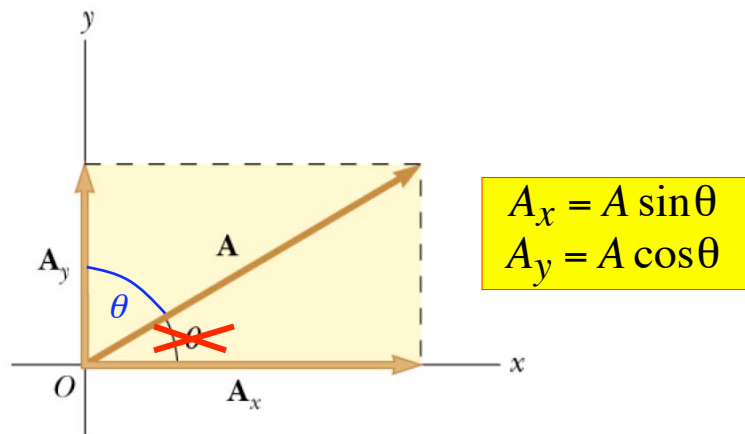
# Components



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**But beware...watch which angle you use.**



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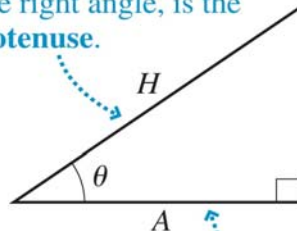
## Trigonometry reminder: “SOHCAHTOA”

$$\sin \theta = \frac{O}{H}$$

$$\cos \theta = \frac{A}{H}$$

$$\tan \theta = \frac{O}{A}$$

The longest side, opposite to the right angle, is the **hypotenuse**.



This is the side **opposite** to the angle.

This is the side **adjacent** to the angle.

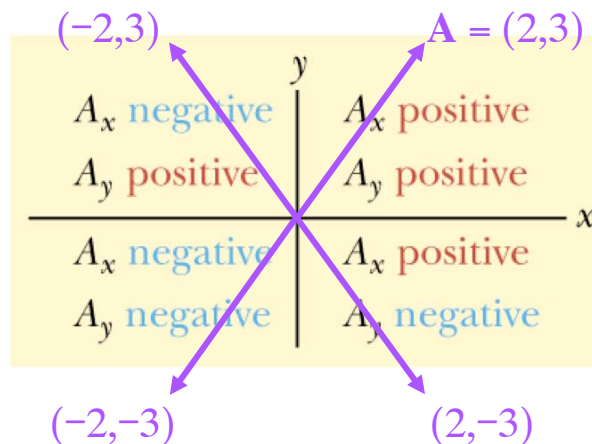
To determine the x- and y-axis components of a vector it is useful to remember “SOH CAH TOA”

For example, the x-axis component would be  $A = H \cos \theta$

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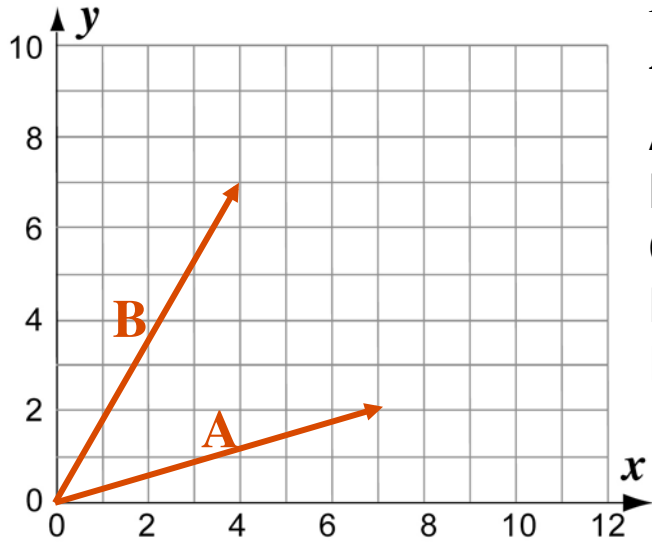
Depending on a vector’s direction, the components  $A_x$  and  $A_y$  can be positive or negative:



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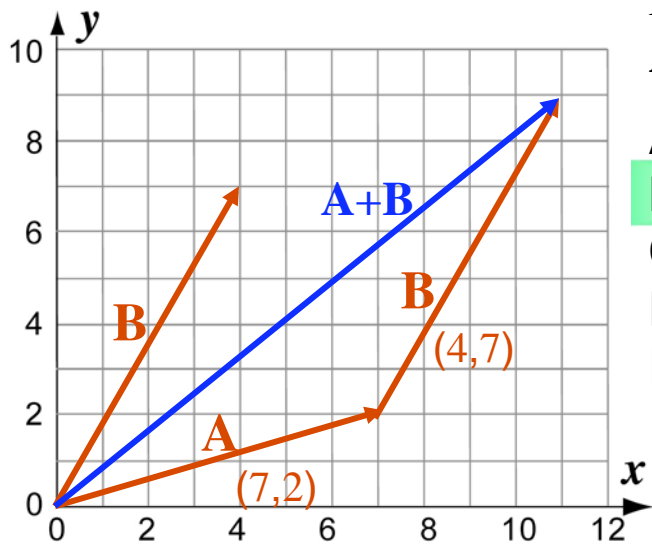
Problem:  
 $\mathbf{A} + \mathbf{B} = ?$

- A. (9,8)
- B. (11,9)
- C. (12,10)
- D. (28,14)
- E. (-3,5)

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Problem:  
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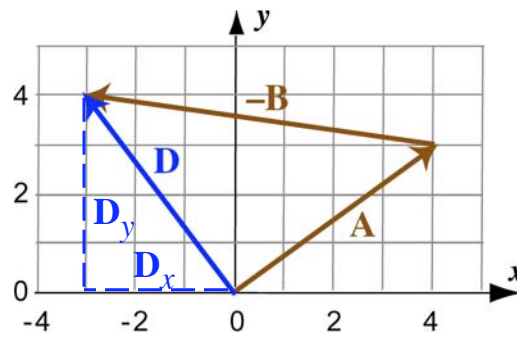
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Consider two vectors  $\mathbf{A} = (4,3)$  and  $\mathbf{B} = (7,-1)$ . The magnitude of  $\mathbf{A}-\mathbf{B}$  is closest to...

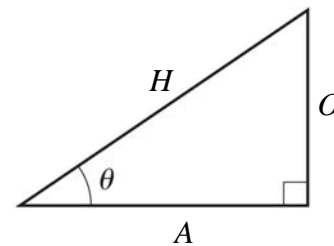
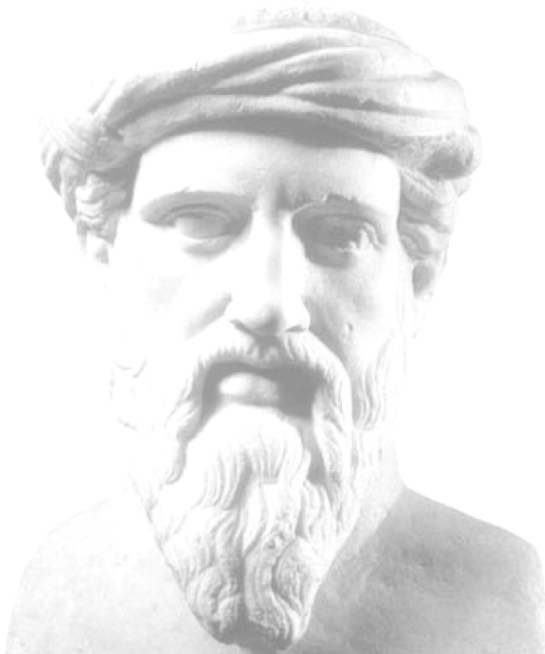
- 1) 2   2) 5   3) 7   4) 11   5) 12



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Meet Pythagoras...



Length of hypotenuse  $H$

$$H = \sqrt{A^2 + O^2}$$

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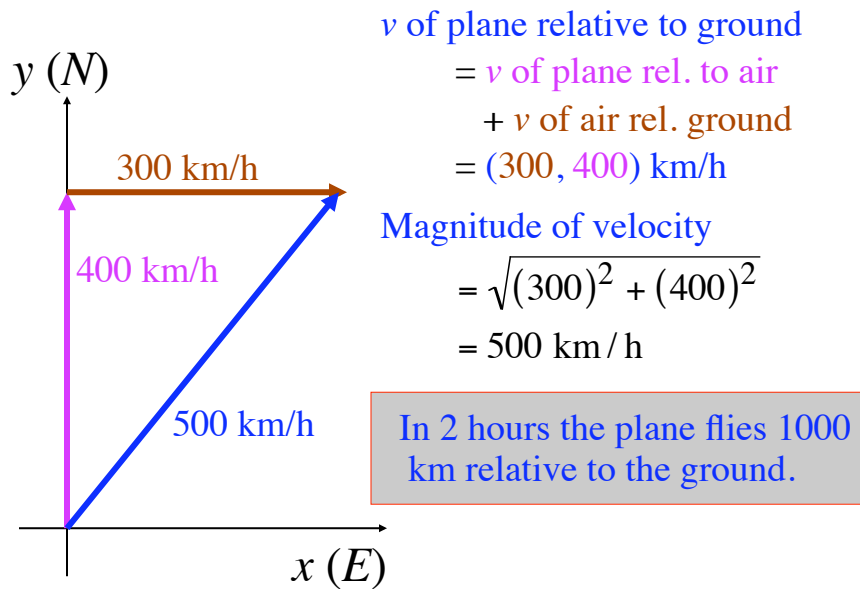
A jet flies at an “airspeed” of 400 km/h. A novice pilot sets a course to travel due north, not realizing that there is a constant crosswind from the west of 300 km/h. Relative to its starting point, the distance the plane flies in 2 h is closest to...

- 1) 500 km
- 2) 700 km
- 3) 800 km
- 4) 1000 km
- 5) 1200 km
- 6) 1400 km



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