PHYS1114: College Physics 1

Lecture 2:
Vector Addition & Subtraction

Professor Kenny L. Tapp

What is a Vector?

- A *vector* is a quantity that has both **magnitude** and **direction**.

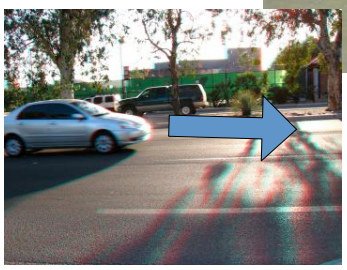

Deanna Lemley


Quinn Gorges


Jordan Gibbon


Molly Butler


Hien Duong


Bobby Moore

Michael Dean

Vectors and their Properties

Vector

- Magnitude & Direction

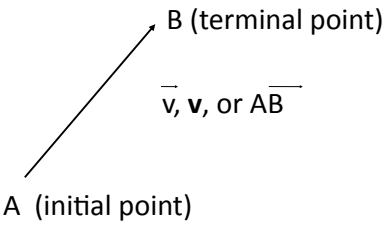
i.e.

- instantaneous velocity $\vec{v}$
- instantaneous acceleration $\vec{a}$

Scalar

- Magnitude only

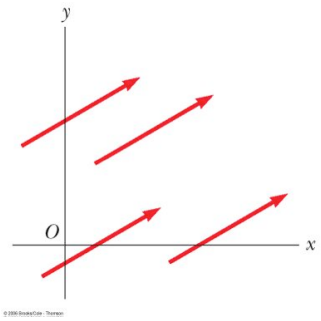
Vectors Represented by an Arrow



Equality of Two Vectors

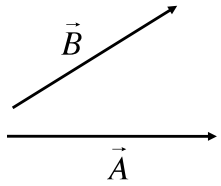
Two vectors are **equal** if they have the *same magnitude & direction*

- Are the vectors here equal?



Vector Addition

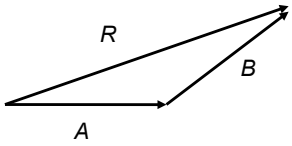
Given two vectors $\vec{A}$ & $\vec{B}$, what is $\vec{A} + \vec{B}$?

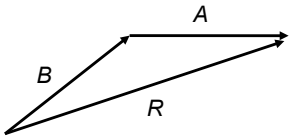


Graphical Techniques of Vector Addition

"Tip-to-Tail Method"

- Two vectors can be added by placing the *tail* of the 2nd on the *tip* of the 1st

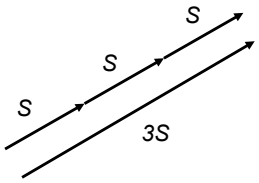




***Multiplying** a Vector by a Scalar*

- Given *S*, what is *3S* ?

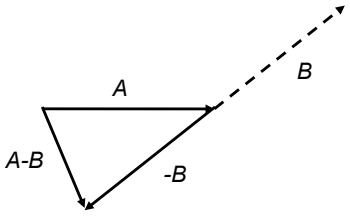
3S = S + S + S



Graphical Techniques of Vector Addition

- What about subtraction?

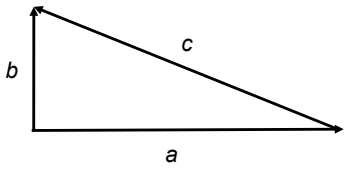
A - B = A + (-B)



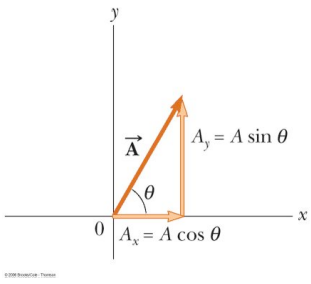
QUICK QUESTION 1

The vector *c* in the diagram is equal to

1. *a* + *b*
2. *b* + *a*
3. *a* - *b*
4. *b* - *a*
5. None of these



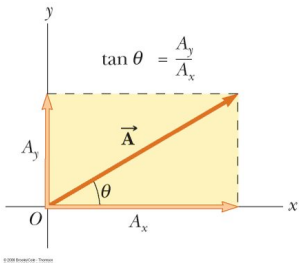
Components of a Vector



$$A = A_x + A_y$$

where A_x and A_y are the *components* of the vector A.

Components of a Vector



$$A = A_x + A_y$$

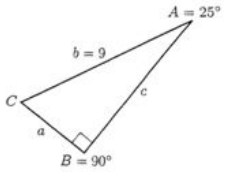
Notice also that…

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

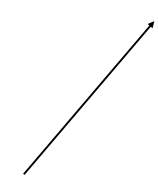
$$\tan\theta = \frac{A_y}{A_x}$$

QUICK QUESTION 2

What are the values of the sides c and a in triangle ABC?



Vectors Represented by an Arrow

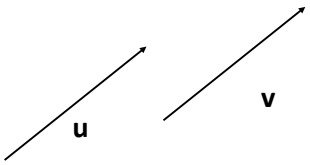


B (terminal point)

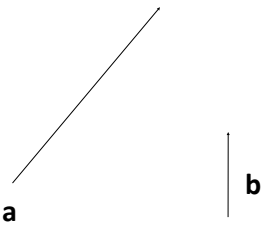
$\vec{v}$, **v**, or $\overrightarrow{AB}$

A (initial point)

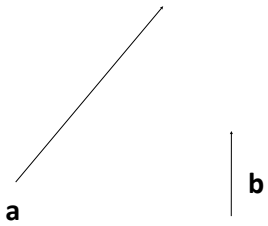
If two vectors, **u** and **v**, have the same length and direction, we say they are equivalent



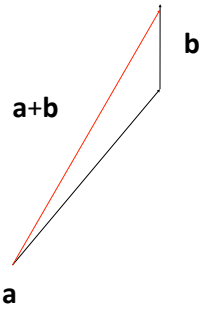
Vector addition



Vector addition: **a** + **b**



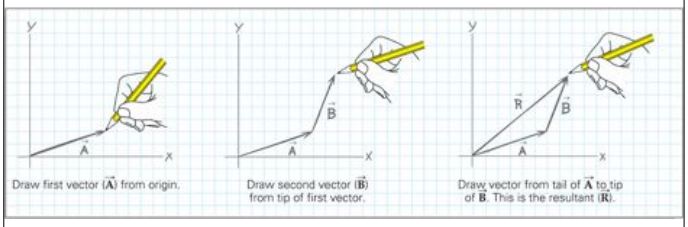
Vector addition: **a** + **b**



Vector Addition and Subtraction

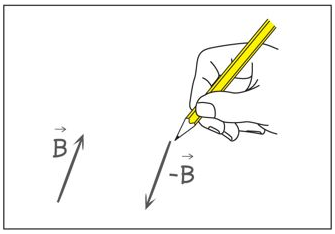
Geometric methods of vector addition

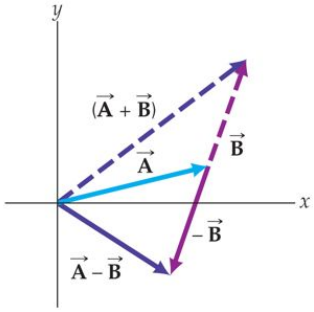
Triangle method:



Vector Addition and Subtraction

The negative of a vector has the same magnitude but is opposite in direction to the original vector. Adding a negative vector is the same as subtracting a vector.





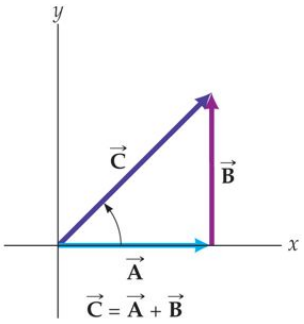
Vector Addition and Subtraction

Vector Components and the Analytical Component Method

If you know A and B, here is how to find C:

$$C = \sqrt{A^2 + B^2}$$

$$\theta = \tan^{-1}\left(\frac{B}{A}\right)$$



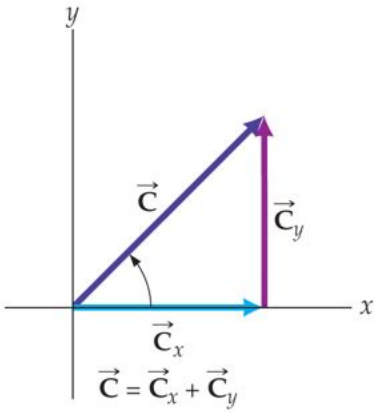
Vector Addition and Subtraction

The components of C are given by:

$$C_x = C\cos\theta$$
$$C_y = C\sin\theta$$

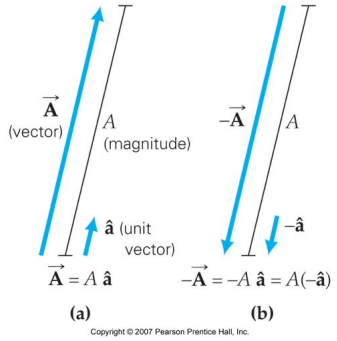
Equivalently,

$$\theta = \tan^{-1}\left(\frac{C_y}{C_x}\right)$$



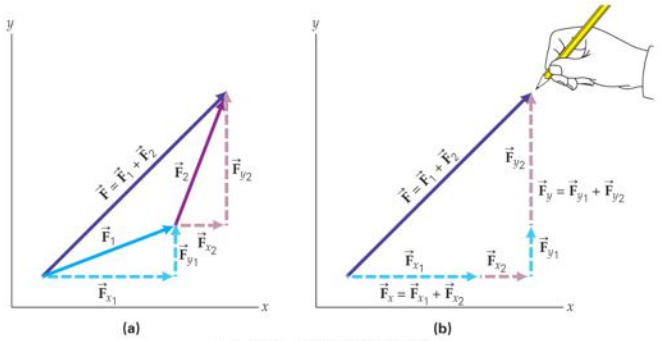
Vector Addition and Subtraction

Vectors can also be written using unit vectors:

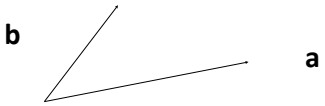


Vector Addition and Subtraction

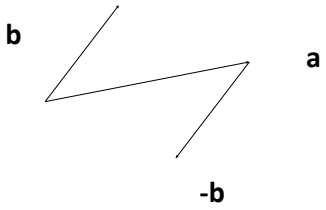
Vectors can be resolved into components and the components added separately; then recombine to find the resultant.



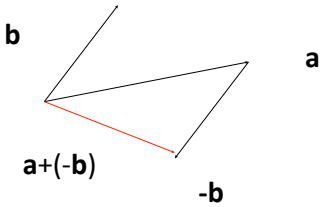
Subtraction



Subtraction

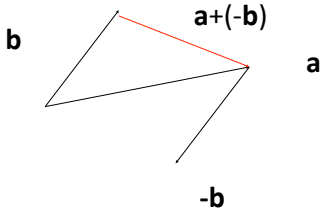


Subtraction

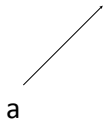


Subtraction

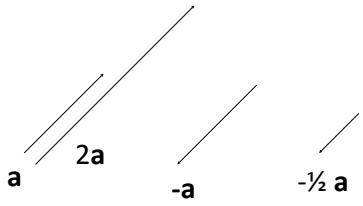
If **a** and **b** share the same initial point, the vector **a**-**b** is the vector from the terminal point of **b** to the terminal point of **a**



Scalar Multiplication



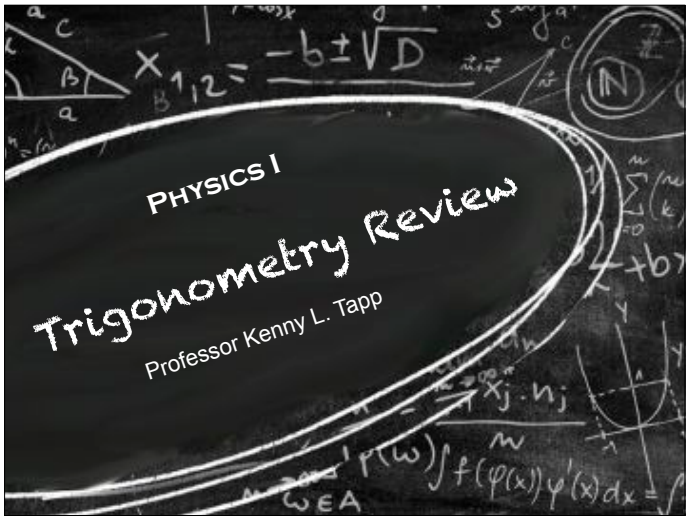
Scalar Multiplication



Properties of Vectors

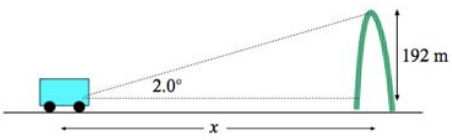
Suppose a, band c are vectors, *c* and *d* are scalars

1. **a**+**b**=**b**+**a**
2. **a**+(**b**+**c**)=(**a**+**b**)+**c**
3. **a**+**0**=**a**
4. **a**+(-**a**)=**0**
5. *c*(**a**+**b**)=*c***a**+*c***b**
6. (*c*+*d*)**a**=*c***a**+*d***a**
7. (*cd*)**a**=*c*(*d***a**)
8. 1**a**=**a**



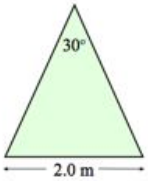
Question 5:

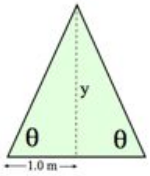
- This monument rises to a height of 192m. You estimate your line of sight with the top of the arch to be 2.0◦ above the horizontal. Approximately how far (in kilometers) are you from the base of the arch?



Question 6:

- The silhouette of a Christmas tree is an isosceles triangle. The angle at the top of the triangle is 30.0◦, and the base measures 2.00m across. How tall is the tree?





Question 7:

"Be the ball, Danny, be the ball."

- A golfer, putting on a green, requires three strokes to “hole the ball”. During the first putt, the ball rolls 5.0 m due east. For the second putt, the ball travels 2.1 m at an angle of 20.0◦ north of east. The third putt is 0.50 m due north. What displacement (magnitude and direction relative to due east) would have been needed to “hole the ball” on the very first putt?