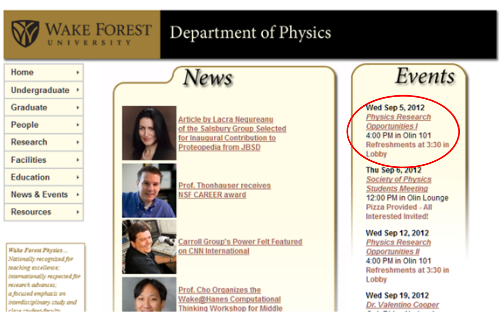
PHY 113 A General Physics I
9-9:50 AM MWF Olin 101

Plan for Lecture 4:

Chapter 3 – Vectors

1. Abstract notion of vectors
2. Displacement vectors
3. Other examples



No.	Lecture Date	Topic	Text Sections	Problem Assignments	Assignment Due Date
1	08/29/2012	Units & measurement	1.1-1.6	1.2,1.6,1.13,1.20	
2	08/31/2012	Motion in 1d -- constant velocity	2.1-2.3	2.1,2.8	09/07/2012
3	09/03/2012	Motion in 1d -- constant acceleration	2.4-2.8	2.13,2.16	09/07/2012
4	09/05/2012	Vectors	3.1-3.4	3.3,3.22	09/07/2012
5	09/07/2012	Motion in 2d	4.1-4.3	4.3,4.19	09/10/2012
6	09/10/2012	Circular motion	4.4-4.6		09/12/2012
7	09/12/2012	Newton's laws	5.1-5.6		09/14/2012
8	09/14/2012	Newton's laws applied	5.7-5.8		09/17/2012
	09/17/2012	Review	1-5		
	09/19/2012	Exam	1-5		
9	09/21/2012	More applications of Newton's laws	6.1-6.4		09/24/2012
10	09/24/2012	Work	7.1-7.4		09/26/2012

iclicker question

A. Have you attended a tutoring session yet?
B. Have you attended a lab session yet?
C. Have you attended both tutoring and lab sessions?

Fall 2012 Schedule
for N. A. W. Holzwarth

	Monday	Tuesday	Wednesday	Thursday	Friday
8:00-9:00	Lecture Preparation/ Office Hours	Lecture Preparation/ Office Hours	Lecture Preparation/ Office Hours	Lecture Preparation/ Office Hours	Lecture Preparation/ Office Hours
9:00-10:00	General Physics I PHY113		General Physics I PHY113		General Physics I PHY113
10:00-11:00	Classical Mech PHY711		Classical Mech PHY711		Classical Mech PHY711
11:00-12:30	Office Hours	Physics Research	Office Hours	Physics Research	Office Hours
12:30-2:00	Condensed Matter Theory Journal Club		Physics Research		Physics Research
2:00-3:30	Physics Research				
3:30-5:00			Physics Colloquium		CEES -- Renewable Energy Research

iclicker question

Have you changed your webassign password yet?
A. yes
B. no

Mathematics Review -- Appendix B Serwey & Jewett

iclicker question

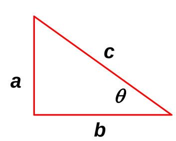
A. Have you used this appendix?
B. Have you used the appendix, and find it helpful?
C. Have you used the appendix, but find it unhelpful?

Mathematics Review -- Appendix B Serwey & Jewett

Quadratic equation:

$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$



Trigonometry:

$$\cos\theta = \frac{b}{c}$$

$$\sin\theta = \frac{a}{c}$$

$$\tan\theta = \frac{a}{b}$$

Differential calculus:

$$\frac{d}{dt} at^n = ant^{n-1}$$

$$\frac{d}{dt} e^{\alpha t} = \alpha e^{\alpha t}$$

$$\frac{d}{dt}\sin(\beta t) = \beta\cos(\beta t)$$

Integral calculus:

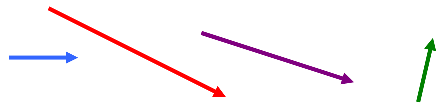
$$\int at^n dt = \frac{at^{n+1}}{n+1}$$

$$\int e^{\alpha t} dt = \frac{1}{\alpha} e^{\alpha t}$$

$$\int \sin(\beta t)dt = -\frac{1}{\beta}\cos(\beta t)$$

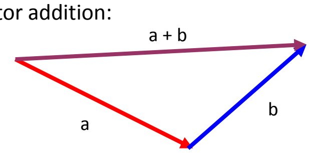
Definition of a vector

1. A vector is defined by its **length** and **direction**.

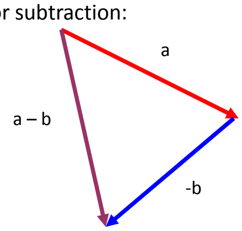


2. Addition, subtraction, and two forms of multiplication can be defined
3. In practice, we can use trigonometry or component analysis for quantitative work involving vectors.
4. Abstract vectors are useful in physics and mathematics.

Vector addition:

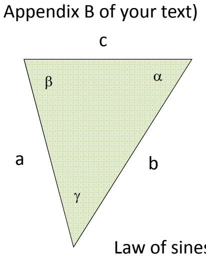


Vector subtraction:



Some useful trigonometric relations

(see Appendix B of your text)



Law of cosines:

$a^2 = b^2 + c^2 - 2bc \cos \alpha$

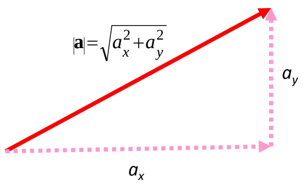
$b^2 = c^2 + a^2 - 2ca \cos \beta$

$c^2 = a^2 + b^2 - 2ab \cos \gamma$

Law of sines:

$$\frac{a}{\sin\alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma}$$

Vector components: $\mathbf{a} = a_x\hat{\mathbf{x}} + a_y\hat{\mathbf{y}} = a_x\hat{\mathbf{i}} + a_y\hat{\mathbf{j}}$



For $\mathbf{a} = a_x\hat{\mathbf{x}} + a_y\hat{\mathbf{y}}$ and $\mathbf{b} = b_x\hat{\mathbf{x}} + b_y\hat{\mathbf{y}}$

$$\mathbf{a} + \mathbf{b} = (a_x + b_x)\hat{\mathbf{x}} + (a_y + b_y)\hat{\mathbf{y}}$$

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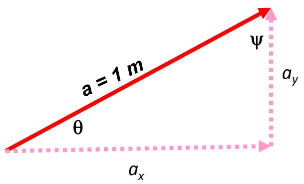
Suppose you are given the length of the vector *a* as shown. How can you find the components?



A. a_x=a cos θ, a_y=a sin θ
B. a_x=a sin ψ, a_y=a cos ψ
C. Neither of these
D. Both of these

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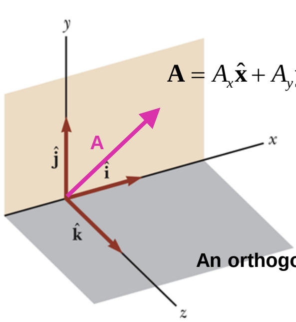
Vector components; using trigonometry

$$\mathbf{A} = A_x\hat{\mathbf{x}} + A_y\hat{\mathbf{y}} + A_z\hat{\mathbf{z}} = A_x\hat{\mathbf{i}} + A_y\hat{\mathbf{j}} + A_z\hat{\mathbf{k}}$$



An orthogonal coordinate system

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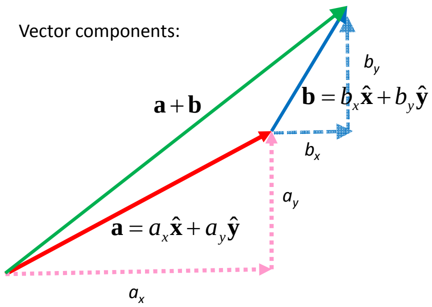
Vector components:



For $\mathbf{a}=a_x\hat{\mathbf{x}}+a_y\hat{\mathbf{y}}$ and $\mathbf{b}=b_x\hat{\mathbf{x}}+b_y\hat{\mathbf{y}}$

$$\mathbf{a}+\mathbf{b}=(a_x+b_x)\hat{\mathbf{x}}+(a_y+b_y)\hat{\mathbf{y}}$$

Examples

Vectors	Scalars
Position **r**	Time *t*
Velocity **v**	Mass *m*
Acceleration **a**	Volume *V*
Force **F**	Density *m/V*
Momentum **p**	Vector components

Vector components

$$\mathbf{R}_1=x_1\hat{\mathbf{x}}+y_1\hat{\mathbf{y}}+z_1\hat{\mathbf{z}}$$

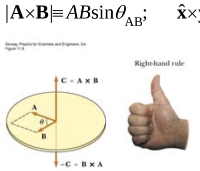
$$\mathbf{R}_2=x_2\hat{\mathbf{x}}+y_2\hat{\mathbf{y}}+z_2\hat{\mathbf{z}}$$

$$\mathbf{R}_1+\mathbf{R}_2=(x_1+x_2)\hat{\mathbf{x}}+(y_1+y_2)\hat{\mathbf{y}}+(z_1+z_2)\hat{\mathbf{z}}$$

Vector multiplication

"Dot" product $\mathbf{A}\bullet\mathbf{B}\equiv AB\cos\theta_{AB}$; $\hat{\mathbf{x}}\bullet\hat{\mathbf{x}}=1$

"Cross" product $|\mathbf{A}\times\mathbf{B}|\equiv AB\sin\theta_{AB}$; $\hat{\mathbf{x}}\times\hat{\mathbf{y}}=\hat{\mathbf{z}}$



Example of vector addition:

$$\gamma = 90^o + 5^o - 21^o = 74^o$$

$$|\mathbf{a}+\mathbf{b}| = 788\,\text{mi}$$

Distance between Chicago and Dallas:

$$|\mathbf{a}+\mathbf{b}| = \sqrt{|\mathbf{a}|^2 + |\mathbf{b}|^2 - 2|\mathbf{a}||\mathbf{b}|\cos\gamma}$$

Webassign version:

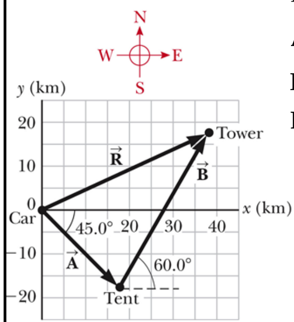
A map suggests that Atlanta is d_1 = 729 mi in a direction of θ_1 = 5.10° north of east from Dallas. The same map shows that Chicago is d_2 = 558 miles in a direction of θ_2 = 20.8° west of north from Atlanta. Modeling the Earth as flat, use this information to find the displacement from Dallas to Chicago.

magnitude ____ miles

direction ____ ° northeast of Dallas

Note: In this case the angle ϕ is actually measured as north of east.

Another example:



Position vectors in km units:

$\mathbf{A} = 17.7\hat{\mathbf{i}} - 17.7\hat{\mathbf{j}}$

$\mathbf{B} = 20.0\hat{\mathbf{i}} + 34.6\hat{\mathbf{j}}$

$\mathbf{R} = \mathbf{A} + \mathbf{B}$

$= 37.7\hat{\mathbf{i}} + 16.9\hat{\mathbf{j}}$

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