Physics 1408-002
Principles of Physics

Lecture 4
– Chapter 3 –
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Announcement I

Lecture note is on the web
Handout (4 slides/page)
http://highenergy.phys.ttu.edu/~slee/1408/

*** Class attendance is strongly encouraged and will be taken randomly. Also it will be used for extra credits.

HW Assignment #1 is placed on MateringPHYSICS, and is due by 11:59pm on Tuesday, 1/20 ("TODAY")

Announcement II

SI session by
Reginald Tuvilla

SI sessions will be at the following times and location.

Monday 4:30 - 6:00pm - Holden Hall 106
Thursday 4:00 - 5:30pm - Holden Hall 106

On-lime Homework

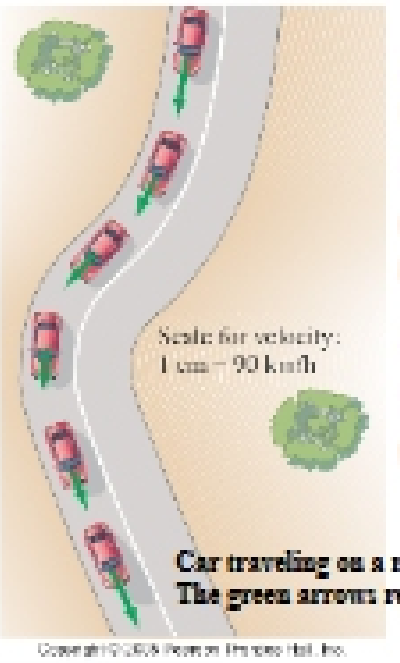
- To access MateringPHYSICS, you must register at http://www.masteringphysics.com/
- Instructions are in the Student Access Kit.
- Your course ID is LEE2009

- Once you are registered, you will be able to download the HW assignment.
- 158 out of 198 registered so far…
- If you do not have the Student Access Kit which comes with a new textbook, you can purchase one on the MasteringPHYSICS site. Please do it ASAP.

Chapter 3
Kinematics in 2, 3-Dimensions ; Vectors

1. Vectors and Scalars
2. Addition of Vectors – Graphical Methods
3. Subtraction of Vectors, and Multiplication of a Vector by a Scalar
4. Adding Vectors by Components
5. Projectile Motion

3.1 Vectors and Scalars



Car traveling on a road, slowing down to round the curve. The green arrows represent the velocity vector at each position.

A vector has magnitude as well as direction.

Some vector quantities:
displacement, velocity, force, momentum

A scalar has only a magnitude.

Some scalar quantities:
mass, time, temperature

Vector

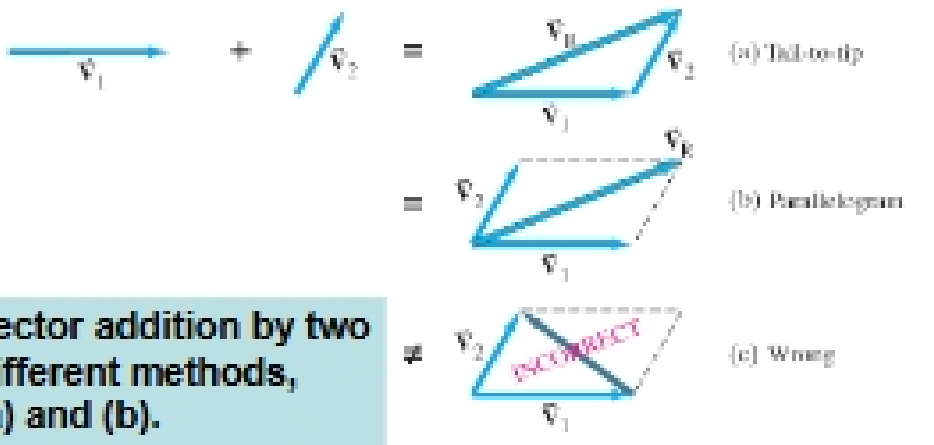
a vector is a quantity that has both magnitude (size) and direction

it is represented by an arrow
- length of the arrow is the magnitude
- arrow indicates direction

symbol for a vector is a letter with an arrow over it

$\vec{A}$

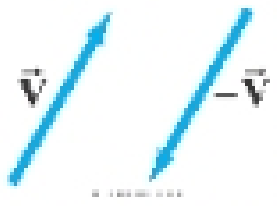
3.2 Addition of Vectors – Graphical Methods



Vector addition by two different methods, (a) and (b).

Part (c) is incorrect.

3.3 Subtraction of Vectors



In order to **subtract** vectors, we define the **negative** of a vector, which has the same magnitude but points in the **opposite** direction.

Then we add the negative vector:

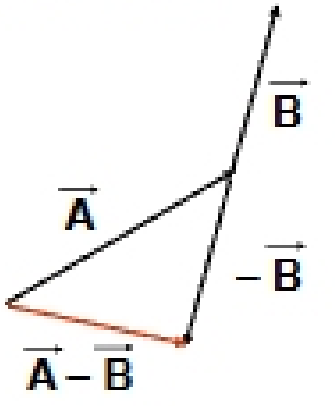
Subtracting two vectors: $\vec{v}_2 - \vec{v}_1$

Vector Subtraction

equivalent to adding negative vector

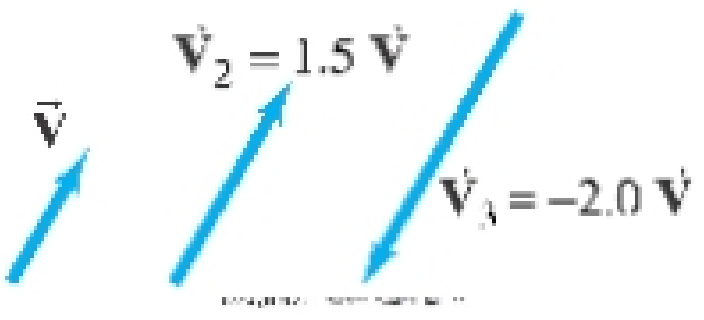
$$\vec{C} = \vec{A} - \vec{B}$$
$$= \vec{A} + (-\vec{B})$$

$C_x = A_x - B_x$
$C_y = A_y - B_y$
$C_z = A_z - B_z$



3.3 Multiplication of a Vector by a Scalar

A vector $\vec{V}$ can be multiplied by a **scalar** c; the result is a vector $c\vec{V}$ that has the same **direction** but a **magnitude** cV. If c is **negative**, the resultant vector points in the opposite direction. (see below)



Scalar Multiplication, again

Multiplication of a vector $\vec{A}$ by a scalar α

Result is a vector $\vec{B}$

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

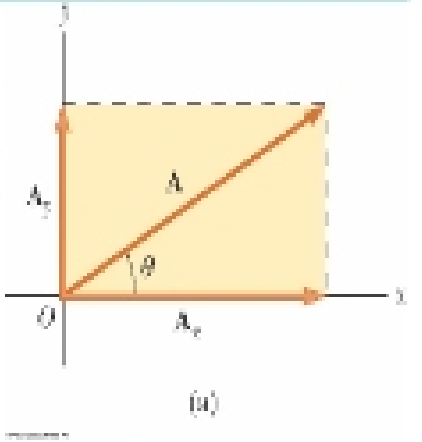
changes magnitude
not direction

flips direction if α negative

3.4 Adding Vectors by Components

Any vector can be expressed as the sum of two other vectors, which are called its components.

- It is useful to use **rectangular components**
  - These are the projections of the vector along the x- and y-axes

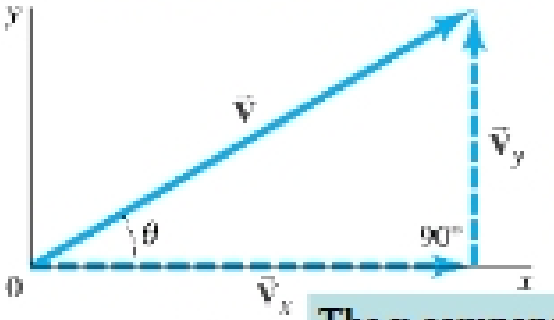


(a)

Terminology

- **A_x and A_y are the *component vectors* of A**

3.4 Adding Vectors by Components



$$V = \sqrt{V_x^2 + V_y^2}$$

$$\tan\theta = \frac{V_y}{V_x}$$

$$\sin\theta = \frac{V_y}{V}$$

$$\cos\theta = \frac{V_x}{V}$$

$$\tan\theta = \frac{V_y}{V_x}$$

$$V^2 = V_x^2 + V_y^2$$

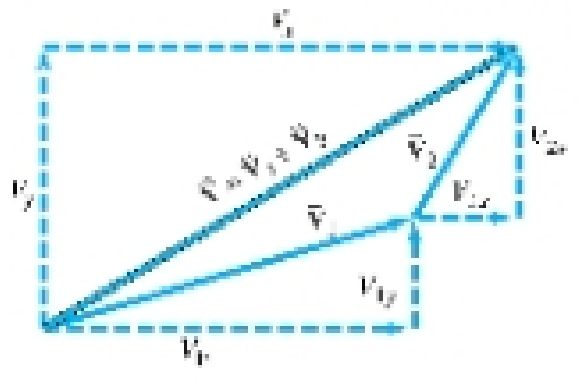
The x-component of a velocity vector is the projection along the x-axis: $V_x = V\cos\theta$

The y-component of a velocity vector is the projection along the y-axis: $V_y = V\sin\theta$

3.4 Adding Vectors by Components

The components of $\mathbf{v} = \mathbf{v}_1 + \mathbf{v}_2$ are

$$v_x = v_{1x} + v_{2x}$$
$$v_y = v_{1y} + v_{2y}$$

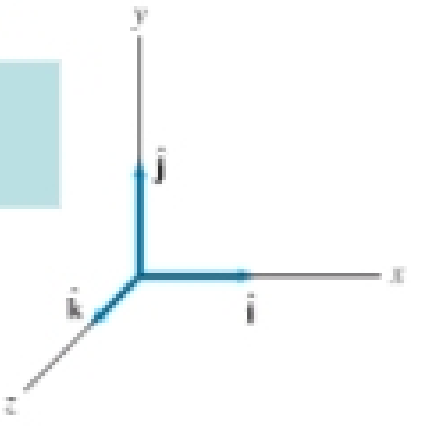


3.5 Unit Vectors

- A *unit vector* is a dimensionless vector with a magnitude of exactly 1.
- Unit vectors are used to specify a direction and have no other physical significance

Using unit vectors, any vector can be written in terms of its components:

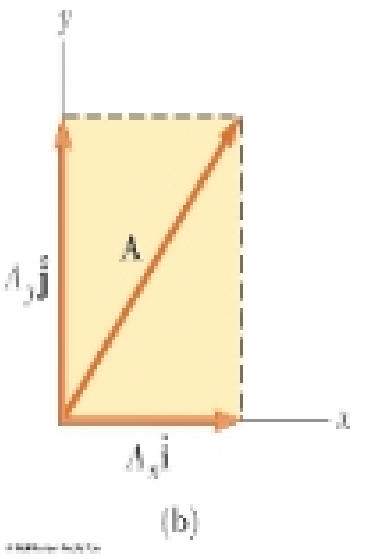
$$\vec{V} = V_x\hat{i} + V_y\hat{j} + V_z\hat{k}.$$



Unit Vectors in Vector Notation

- $\mathbf{A}_x$ is the same as $A_x\,\hat{\mathbf{i}}$ and $\mathbf{A}_y$ is the same as $A_y\,\hat{\mathbf{j}}$
- The complete vector can be expressed as

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



(b)

Vector Addition

Analytically

$$\vec{C} = \vec{A} + \vec{B}$$
$$= (A_x\hat{i} + A_y\hat{j}) + (B_x\hat{i} + B_y\hat{j})$$
$$= (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j}$$
$$= C_x\hat{i} + C_y\hat{j}$$

$$C_x = A_x + B_x$$
$$C_y = A_y + B_y$$
$$C_z = A_z + B_z$$