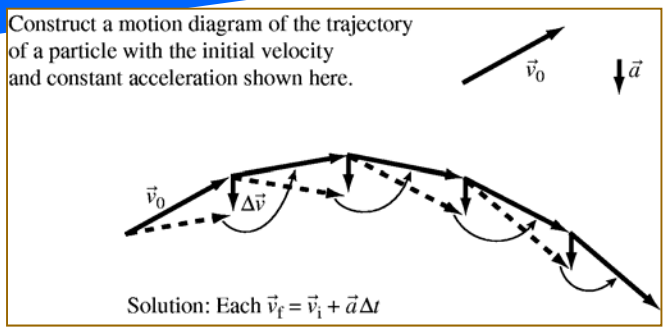
PHYS 210 - General Physics I

18 Sep 19

- Average and instantaneous acceleration
- Problem solving
- Motion at a constant acceleration
- Vectors
- Projectiles



SPS Meeting!

- Thursday, 19 Sept in SCIC 114 at 8:00 pm
- Plan the academic year's activities
- Elect officers (you could be one!)

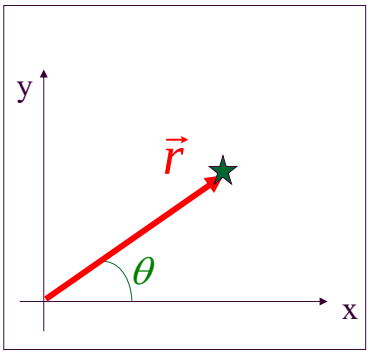
SOCIETY OF PHYSICS STUDENTS

From lab …

Vector components

- A vector can be expressed in terms of its components along a set of axes
- In Cartesian coordinates, we can use simple trig relations to find the components along the x, y, and z axes
- To add/subtract vectors, we add/subtract like components

Vector components



- In **2-D**

$$A_x = A\cos\theta$$

$$A_y = A\sin\theta$$

- The **magnitude** of a vector is given by

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

Unit vectors

$\hat{i}$ $\hat{j}$ $\hat{k}$

- Have a magnitude of one; point in particular directions, depending on choice of coordinate system.
- The Cartesian unit vectors are fixed and point along the Cartesian axes.
- The Cartesian unit vectors are $\hat{i}, \hat{j}, \hat{k}$
- An arbitrary vector can be written in terms of its components as

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

From lab …

1. Suppose $\vec{a} = (-\hat{i}\,5 + \hat{j}\,3)\,m/s^2$

Find the magnitude and direction (angle relative to some axis) of the vector

2. Suppose a velocity vector has a magnitude of 10 m/s and makes an angle of 45° with the +x axis. Write the vector in component (unit vector) form.

From lab …

1. Suppose $\vec{a} = (-\hat{i}\,5 + \hat{j}\,3)\,m/s^2$

Find the magnitude and direction (angle relative to some axis) of the vector

$$a = |\vec{a}| = ((-5)^2 + (3)^2)^{1/2}\,m/s^2 = \sqrt{34}\,m/s^2 \simeq 5.83\,m/s^2$$

$$\theta = \tan^{-1}((3)/(-5)) \simeq -31.0^o \Rightarrow \text{ About } 31^o \text{ above the -x axis.}$$

2. Suppose a velocity vector has a magnitude of 10 m/s and makes an angle of 45° with the +x axis. Write the vector in component (unit vector) form.

$$\vec{v} = (\hat{i}\,v\cos\theta + \hat{j}\,v\sin\theta) = (\hat{i}\,(10m/s)\cos 45^o + \hat{j}\,(10m/s)\sin 45^o)$$

$$\simeq (\hat{i}\,7.07 + \hat{j}\,7.07)\,m/s$$

Vector components

- A vector can be expressed in terms of its components along a set of axes
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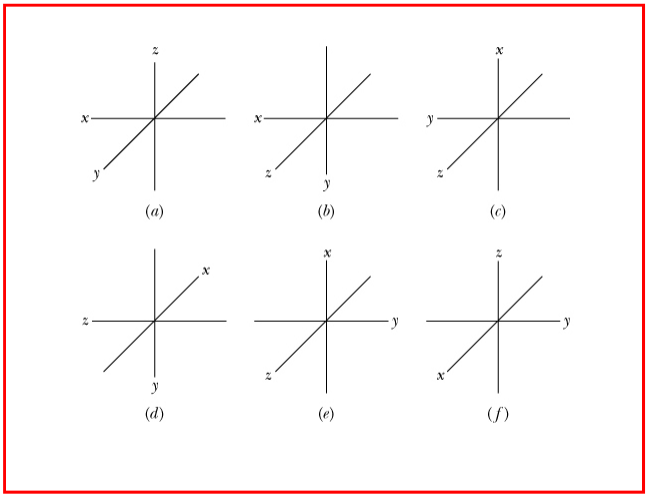
- **To add/subtract vectors, we add/subtract like components**

Vector components

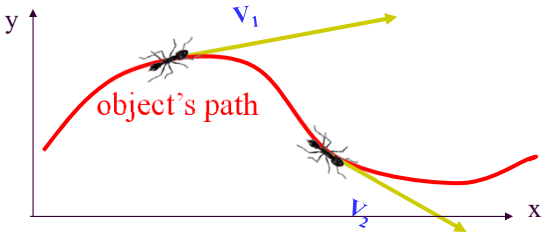
- Add the following vectors:
  1. $\vec{A} = -\hat{i}\,5 + \hat{j}\,3 \quad \vec{B} = \hat{i}\,4 + \hat{j}\,2$
  2. $\vec{C} = -3\hat{i} - \hat{j} \quad \vec{D} = 6\hat{i} + 3\hat{j}$
  3. $\vec{E} = 2\hat{i} + 4\hat{j} + 3\hat{k} \quad \vec{F} = -5\hat{i} + \hat{j} - 2\hat{k}$

Quick!
Which are RH coordinate systems?



Instantaneous Velocity

$$\vec{v} = \frac{d\vec{r}}{dt}$$



$\vec{v}$ is the rate of change of position and can be represented by a vector!

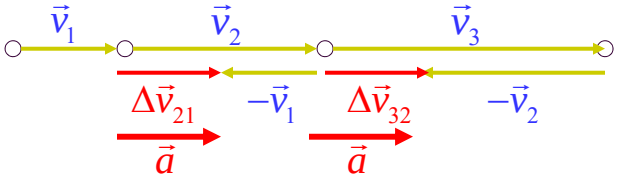
The velocity vector is always tangent to the path (trajectory) of motion in real space

We can interpret $\vec{v}$ as the slope on a graph of x vs. t.

How about acceleration?

- Acceleration in the rate of change in velocity:

$$\vec{a}_{ave} = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$$



How about instantaneous acceleration?

Acceleration (in 1-D) is defined by

$$\vec{a} = \frac{d\vec{v}}{dt}$$

Acceleration is the time rate of change of velocity

Using $\vec{a} = d\vec{v}/dt$, we can interpret $\vec{a}$ as the slope on a graph of v vs. t.

Constant acceleration

- What does it really mean?

  Suppose $a = 1.5\ m/s^2$

  ➢ for each second of motion, the object's speed will increase by *1.5 m/s*.

Sign depends on the coordinate system!!

Constant acceleration

- What does it really mean?
- What if an object is truly in free fall?

$g = 9.8\ m/s^2$, down

Sign depends on the coordinate system!!

Enjoy your Wednesday!