Notes

• Updated Class Schedule on my web page
  - New lab assignments/dates
  - New reading/chapter assignments (i.e., what we are doing each week)

• End of Chapter quizzes coming soon. Will let you know when they are posted
Checklist for Today

• Things that were due last Thursday:
  - Chapter 2 reading
  - Read all handouts from web page
• Things that are due yesterday (Monday):
  - WebCT Prelim (FCI, Math Assess, etc...)
  - Math Quizzes 1 through 10
• Things that are due today:
  - Reading for Chapters 3 & 4
• For this week and/or due next Monday:
  - Recitation: Start Ch. 2 on WebCT
  - All HW2 problems on WebCT due Monday
This Week

Chapters 3 and 4

- Vectors and Two Dimensional Motion

- Do these two chapters together

- Vectors
- Position, Velocity and Acceleration
- Projectile Motion
Vectors

• Why we care about them

• Addition & Subtraction
Why do we care about Vectors?

As you may have noticed, the world is not one-dimensional

- Three dimensions: $X$, $Y$ and $Z$.
- Example:
  1. Up from us
  2. Straight in front of us
  3. To the side from us
    - All at 90 degrees from each other.
      Three dimensional axis.
- Need a way of saying how much in each direction

For this we use VECTORS
Vector and Scalar

- Vectors have a magnitude AND a direction
  - I’m driving 70 miles/hr SouthEast to Houston
- Scalars are just a number
  - My speedometer says 70 m/hr
Where am I?

Let’s say I’m here
You’re here (origin)
I call you on the cell phone. How do I tell you how to get to me?

2 equivalent ways:
1) Travel 11.2 km at an angle of 26.5 degrees
2) Travel 10 km East then 5 km North

My single vector in some funny direction, can be thought of as two vectors in nice simple directions (like X and Y). This can make things much easier
Re-write my location

• Describe my location in terms of the sum of two vectors

\[ \vec{V} = \vec{V}_x + \vec{V}_y \]

\[ |V_x| = |V| \cos \theta \]

\[ |V_y| = |V| \sin \theta \]

• Careful when using the sin and cos
Specifying a Vector

- Two equivalent ways:
  - Components $V_x$ and $V_y$
  - Magnitude $V$ and angle $\theta$

- Switch back and forth
  - Magnitude of $V$
    \[ |V| = \left(v_x^2 + v_y^2\right)^{\frac{1}{2}} \]
    Pythagorean Theorem
  - $\tan \theta = \frac{v_y}{v_x}$

Either method is fine, but you should pick which is easiest, and be able to use both
Unit Vectors

This is how the pros write things!

\( \hat{i} \) means 1 in the x direction

\( \hat{j} \) means 1 in the y direction

\[ \vec{V} = V_x \hat{i} + V_y \hat{j} \]
Unit Vectors

The pros also use:

\( \hat{x} \) is the same as \( \hat{i} \)
\( \hat{y} \) is the same as \( \hat{j} \)

\[ \vec{V} = V_x \hat{x} + V_y \hat{y} \]
Vector in Unit Vector Notation

\[ |V_x| = |V| \cos \Theta \]
\[ |V_y| = |V| \sin \Theta \]
\[ \vec{V} = \vec{V}_x + \vec{V}_y \]
\[ \vec{V} = V_x \hat{i} + V_y \hat{j} \]
\[ \vec{V} = |V| \cos \Theta \hat{i} + |V| \sin \Theta \hat{j} \]
General Addition Example

Add two vectors using the \( \hat{i} \)-hats and \( \hat{j} \)-hats

\[
\vec{D}_R = \vec{D}_1 + \vec{D}_2
\]

\[
\vec{D}_1 = 10 \text{ km } \hat{i} + 0 \text{ km } \hat{j}
\]

\[
\vec{D}_2 = 0 \text{ km } \hat{i} + 5 \text{ km } \hat{j}
\]

\[\Rightarrow \vec{D}_R = 10 \text{ km } \hat{i} + 5 \text{ km } \hat{j}\]
Motion in 2-Dimensions

• Moving from Chapter 3 to Chapter 4

• This is what all the setup has been for!

• Motion in two and three dimensions
  – For now we'll ignore air friction
Position in 2 dimensions

Write $\vec{R}$ as our position, relative to the origin in 2 dimensions

$$\vec{R} = X\hat{i} + Y\hat{j}$$
Velocity in 2 dimensions

If $\vec{R}$ is the position, then

$$\vec{V} = \frac{d\vec{R}}{dt}$$

$$= \frac{d(X\hat{i} + Y\hat{j})}{dt}$$

$$= \frac{dX}{dt} \hat{i} + \frac{dY}{dt} \hat{j}$$

$$= V_x \hat{i} + V_y \hat{j}$$

Note: We have used $\frac{d\hat{i}}{dt} = 0 = \frac{d\hat{j}}{dt}$
Acceleration in 2 dimensions

If \( \vec{R} \) is the position, then

\[
\vec{a} = \frac{d\vec{V}}{dt}
\]

\[
= \frac{d(V_x \hat{i} + V_y \hat{j})}{dt}
\]

\[
= \frac{dV_x}{dt} \hat{i} + \frac{dV_y}{dt} \hat{j}
\]

\[
= a_x \hat{i} + a_y \hat{j}
\]
Projectile Motion

The *physics* of the universe:

The **horizontal and vertical Equations of Motion** behave **independently**

This is why we use vectors in the **first place**