Quiz

1. How many math quizzes have you finished?

2. When is Chapter 1 HW due?

3. When are you going to do Lab 2?

Name
Section
UIN
Email
Checklist for Today

• Things that were due last Thursday:
  - Chapter 1 reading
  - Read all handouts from web page

• Things that are due yesterday (Monday):
  - WebCT warm-ups (FCI, Math Assess, etc...)
  - Math Quizzes 1 through 10

• Things that are due today:
  - Reading for Chapter 2

• For this week and/or due next Monday:
  - Recitation: Read Lab 2 (on web), start Ch. 1 on WebCT
  - All HW1 problems on WebCT due Monday
Chapter 2: Motion in 1-Dimension

• Motion in 1-dimension
  - Position
  - Velocity
  - Acceleration
• Problem Solving
  - Tricks
  - Methods
• Examples
Describing Motion

Interested in two key ideas:

• **How** objects move as a function of time
  - Kinematics
  - Chapters 2, 3 and 4

• **Why** objects move the way they do
  - Dynamics
  - Do this in Chapters 5 and 6
Notes before we begin

• This chapter is a good example of a set of material that is best learned by doing examples

• We’ll do some examples today

• Lots more next time…
Equations of Motion

We want Equations that describe

• **Where** am I as a function of time?

• **How fast** am I moving as a function of time?

• **What direction** am I moving as a function of time?

• Is its velocity **changing**? Etc.
Moving Car

The example from last time:

\[ X = ct^2 \]

- What’s the velocity at \( t=1 \) sec?
Check: Non-Constant Velocity

- $X = ct^2$ with $c = 11 \text{ ft/sec}^2$
- $V = \frac{dX}{dt} = 2ct$
  - The velocity is:
    - “non-Constant”
    - a “function of time”
    - “Changes with time”
  - $V=0 \text{ ft/s at } t_0=0 \text{ sec}$
  - $V=22 \text{ ft/s at } t_1=1 \text{ sec}$
  - $V=44 \text{ ft/s at } t_2=2 \text{ sec}$
Acceleration

- If your velocity is changing, you are "accelerating"
  - You hit the *accelerator* in your car to speed up at a stop light
    - (Ok...It’s true you also hit it to stay at constant velocity, but that’s because friction is slowing you down...we’ll get to that later...)

- How quickly is the velocity changing? That’s our Acceleration
Acceleration

- Acceleration is the “Rate of change of velocity”
- Said differently: “How fast is the Velocity changing?” “What is the change in velocity as a function of time?”

\[ \text{Accel} = \frac{dV}{dt} \]
Position, Velocity and Acceleration

• All three are related
  - Velocity is the \textit{derivative} of position with respect to time
  - Acceleration is the \textit{derivative} of velocity with respect to time
  - Acceleration is the \textit{second derivative} of position with respect to time

• Calculus is REALLY important

• Derivatives are something we’ll come back to over and over again
Important Equations of Motion

If the acceleration is constant

\[ \vec{v} = \vec{v}_0 + \vec{a}t \]

\[ \vec{x} = \vec{x}_0 + \vec{v}_0 t + \frac{1}{2} \vec{a} t^2 \]

Position, velocity and Acceleration are vectors. More on this in Chap 3
Example

You have an equation of motion where:

\[ X = X_0 + V_0 t + \frac{1}{2}at^2 \]

where \( X_0, \ V_0, \) and \( a \) are constants.

What is the velocity and the acceleration?

\[ V = \frac{dx}{dt} = 0 + V_0 + at \]

- Remember that the derivative of a constant is Zero!!

\[ \text{Accel} = \frac{dV}{dt} = \frac{d^2x}{dt^2} = 0 + 0 + a \]
Show that for constant acceleration:

\[ 2a \ (\Delta x) = V_f^2 - V_0^2 \]
Conceptual Example

• If the velocity of an object is zero, does it mean that the acceleration is zero?

• If the acceleration is zero, does that mean that the velocity is zero?
Problem Solving Overview

- There are good general problem solving TRICKS
  - Units checking
  - Special case checking
  - Etc.

- There are good METHODS of problem solving that prepare you for the exams

We'll use both to solve problems in lecture
First Things First! Trick #1

What’s the first thing you should do when you’re given a problem?

• Draw a diagram!!!
  - Usually good for some partial credit

• List **givens** and **wants** as variables
  - Also a good bet for partial credit

Then use reasonable equations and solve with your variables
Trick #2: Units

• The speed of your car isn’t measured in seconds, it’s measured in meters/second (or miles/hour etc.)

• Paying attention to the units will help you catch LOTS of mistakes on exams, quizzes and homework!!
  - If we ask what the mass of your car is, make sure your answer is in kg (or lbs etc.)

Trick #2: Every time you finish a problem **ALWAYS** check the units of your answer!!
Tricks #3 and #4

Check *Reasonableness*:

- Can you find another way to do the same problem that gives the same answer? *Trick #3*

- Simple numbers give expected numerical answers? Example: Zero, or infinity *Trick #4*
How to use the Tricks and Methods

• Next we’ll do an example problem like one of the homework problems in the text book

• Solve this problem using the right method
  - Draw a diagram
  - Convert the numbers to variables
  - Solve to get a formula
  - Plug in the numbers at the end
  - Check
    • Reasonable numbers?
    • Silly numbers?
    • Another way to do the same problem?
Car Crash Test Design

You are designing a crash test setup for a car maker. You can accelerate a car from rest with a constant acceleration of 1.00 m/s² so you can make the car crash into a wall. (This is the last time you will see numbers in a problem in lecture).

1. If the path is 200m long, what is the velocity of the car just before/as it hits the wall?

2. For the same acceleration, if you want the car to hit the wall with a speed of 30m/s (about 60 mi/hr), what minimum length must you have?
How quickly can you stop a car?

You're driving along a road at some constant speed, \( V_0 \), and slam on the breaks and slow down with constant deceleration \( a \).

1. How much time does it take to stop?
2. How far do you travel before you come to a stop?

When you hit the brakes, where you stop
Free Fall

• Free fall is a good example for one dimensional problems

• Gravity

• Things accelerate towards earth with a constant acceleration I.e., \( a=g=9.8\text{ m/s}^2 \) towards the earth

  - We’ll come back to Gravity a lot!
Throw a Ball up

You throw a ball upward into the air with initial velocity $V_0$. Calculate:

a) The time it takes to reach its highest point (the top).

b) Distance from your hand to the top.

c) Time to go from your hand and come back to your hand.

d) Velocity when it reaches your hand.

e) Time from leaving your hand to reach some random height $h$. 
A speeder passes you (a police officer) sitting by the side of the road and maintains their constant velocity $V$. You immediately start to move after the speeder from rest with constant acceleration $a$.

- How much time does it take to ram the speeder?
- How far do you have to travel to catch the speeder?
- What is your final speed?
Results of Math Quizzes

The average of all Math Quizzes taken so far (not the Math Assessment) is about an 8.1 with a standard deviation of just above 1.1.

How to evaluate where you stand. If the average of the scores of all the quizzes you have taken is:

• 95% or above: Well prepared
• 85% - 90%: Good, but needs to be better
• 80% - 85%: Ok, but really needs some work
• 75% - 80%: Hmmm...maybe get some help
• 75% or below: Careful...Definitely get help! Maybe drop...
Next Week

- Reading and Lecture: *Chapters 3 and 4, Vectors and Two Dimensional Motion*

- Recitation and WebCT Homework:
  - **HW**: HW1 due Monday
  - **Recitation**: Chapter 2
  - **Recitation Prep**: Do HW2 on paper, start turning in on WebCT before recitation
  - **Lab**: No lab next week