In Class Quiz

Write down the most important “student case study” from the Frequently Asked Questions handout.
Announcements: WebCT

• **Having trouble getting started?** Try:
  - ITS Help sessions
  - Open access lab/student computing
  - Instructions on `faculty.physics.tamu.edu/toback/WebCT`
  - email to `webct@physics.tamu.edu`

• Check your neo email account for announcements

• Still working on Math Quiz figures... sorry about that..

• Finish your “Preliminary Course Materials”
Due dates coming up

**Week 1 (This week):**
- Lecture: Chapter 1 (Reading, but nothing due)
- Recitation & Lab: Lab 1 (A&B)
- Homework due: None

**Week 2 (Next week):**
- Homework (Monday): Math quizzes
- Lecture: Chapter 2
- Recitation & Lab: Chapter 1 and Lab 2

**Week 3 (The week after that):**
- Homework due (Monday): Chapter 1
- Lecture: Chapter 3 & 4
- Recitation: Chapter 2 and Lab 3

• Etc..
Chapter 1: Calculus

• Won’t cover the chapter in detail
• This is a chapter that is best learned by DOING
• We’ll cover it quickly
  - Lots more examples in Chapter 2
  - Lots of practice in Math Quizzes on WebCT (when they’re fixed)
Where are we going?

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 my speed changing? Etc.
Use calculus to solve problems!
Motion in One Dimension

- Where is the car?
  - $X=0$ feet at $t_0=0$ sec
  - $X=22$ feet at $t_1=1$ sec
  - $X=44$ feet at $t_2=2$ sec

- Since the car’s position is changing (i.e., moving) we say this car has “speed” or “velocity”

- Plot position vs. time

- How do we get the speed from the graph?
Questions:

- How fast is my position changing?
- What would my speedometer read?
How do we Calculate the speed?

- Define speed: “Change in position during a certain amount of time”

- Math: Calculate from the **Slope**: The “Change in position as a function of time”
  
  - Change in Vertical divided by the Change in Horizontal
  
  - Speed = $\frac{\Delta X}{\Delta t}$
Constant Speed

Equation of Motion for this example is a straight line

Write this as:

\[ X = bt \]

- Slope is constant
- Velocity is constant
- Easy to calculate
- Same everywhere
Moving Car

A harder example:

\[ X = ct^2 \]

- What’s the speed at \( t = 1 \) sec?

Want to calculate the “Slope” here

What would the speedometer say?
Derivatives

• To find the slope at time $t$, just take the “derivative”

• For $X=ct^2$, Slope = $V = \frac{dx}{dt} = 2ct$

• “Gerbil” derivative method
  - If $X = at^n \rightarrow V = \frac{dx}{dt} = nat^{n-1}$
    - “Derivative of $X$ with respect to $t$”

• More examples
  - $X = qt^2 \rightarrow V = \frac{dx}{dt} = 2qt$
  - $X = ht^3 \rightarrow V = \frac{dx}{dt} = 3ht^2$
Common Mistakes

The trick is to remember what you are taking the derivative “with respect to”

More Examples (with $a=$constant):

• What if $X=2a^3t^n$?
  - Why not $\frac{dx}{dt} = 3(2a^2t^n)$?
  - Why not $\frac{dx}{dt} = 3n(2a^2t^{n-1})$?

• What if $X=2a^3$?
  - What is $\frac{dx}{dt}$?
  - There are no $t$'s!!! $\frac{dx}{dt} = 0$!!
  - If $X=22$ feet, what is the velocity? =0!!!
Going the other way: Integrals

- What if you know how fast you've been going and how long you've been driving?
- How can you figure out how far you've gone?
- What would your car’s odometer read?
Getting the Displacement from Velocity

- If you are given the speed vs. time graph you can find the total distance traveled from the area under the curve:
  \[ \Delta x = v_0 t + \frac{1}{2} a t^2 \]
- Can also find this from integrating...

\[ x = \int_0^t v \, dt \]

Slope is constant = Constant acceleration
Definite and Indefinite Integrals

How to you calculate the Value of an integral?

In many ways an integral is an anti-derivative. For $c = \text{const}$

$$\Rightarrow \int (c) \, dt = ct + b$$

where $b$ is an arbitrary constant and is

added to the right side of the equation

$$\Rightarrow \frac{d(ct + b)}{dt} = c$$

If I know where my region of integration begins and ends:

(assuming $a$, $b$, and $c$ are constants)

$$\int_{a}^{b} c \, dt = \left. ct \right|_{t=a}^{t=b} = cb - ca$$
Some Integrals

Make this more general:

\[ \int a \, dt = at + c \]
\[ \int at^m \, dt = a\left(\frac{t^{m+1}}{m+1}\right) + c \]

Check "anti-derivative"

\[
\frac{d}{dt} \left( \int at^m \, dt \right) = \frac{d}{dt} \left( a\left(\frac{t^{m+1}}{m+1}\right) + c \right)
\]
\[
= (m + 1) \cdot a\left(\frac{t^{(m+1)-1}}{m+1}\right) + 0
\]
\[
= at^m
\]
Our Example

\[ x - x_0 = \int_0^t v \, dt \]

\[ = \int_0^t (v_0 + at) \, dt \]

\[ = (v_0 t + \frac{1}{2} at^2) \bigg|_0^t \]

\[ = v_0 t + \frac{1}{2} at^2 \]
For Next Week

• Before Lecture:
  - Read Chapter 2
  - Math Quizzes due Monday

• In Lecture
  - Cover Chapter 2

• Recitation, Lab and Homework:
  - Start Chapter 1 problems and exercises before recitation
  - Read your lab materials before lab