Reminders

- Survey due today if possible
- Assessment test due on Thursday
- hw 1 is open, due 1/22
- yesterday’s recording on Canvas
- Today’s annotated notes and recording will be on Canvas some time this afternoon.
What is Calculus?

And why do we need to study it?

• Quick answer to the second question: Because it can be used to solve many problems!

The Key Ideas

• We will introduce the concepts with an example:

Velocity — Location

• Your car has a speedometer (showing current velocity) and an odometer (showing distance covered, or location along a highway).

• Speed versus velocity: velocity has a direction, in this semester just forward and backward, or up and down, distinguished by a plus or minus sign.

• Profound Fact: Velocity and Location are related. One determines the other.

• Think of both as functions of time $t$:
  – $v(t)$ is velocity at time $t$
  – $d(t)$ is location (distance) at time $t$

• If we know our location function $d$ we should be able to compute our velocity function $v$,
and if we know our velocity function $v$ (and our location at time $t = 0$, say) we should be able to compute our location function.

- Note: we do not just compute location or velocity at a specific time. We know one function for all (relevant) time and compute the other for all (relevant) time.

- This is what Calculus is all about!
  - $v \rightarrow d$: integration
  - $d \rightarrow v$: differentiation
Falling Objects

- simple physical example: falling object, ignore air resistance, consider gravity constant. (It actually does depend on altitude and location on earth.)

- Observation: Velocity increases by 32 ft/sec every second. We say that the acceleration is 32 feet per second squared.

- Let \( v(t) \) be the downward velocity, and assume
  \[ v(0) = 0. \]

- Then clearly
  \[ v(t) = 32t \]

- How far does the object fall in \( t \) seconds?

- In other words, what is \( d(t) \)? (Think of \( d \) as distance or depth.)

- Let’s figure it out.
Going the other way

- Suppose we know the distance. How can we figure out the velocity?

- Let’s apply the ideas to a situation where we already know the answer!

- Suppose

  \[ d(t) = 16t^2 \]

- What is \( v(t) \). Of course we should get

  \[ v(t) = 32t \]

  but suppose we don’t know that yet.
The Fundamental Theorem of Calculus
The Plan (for both Math 1210 and 1220)

• Make the idea $h \rightarrow 0$ precise. (This will give rise to the concept of limits.)

• Make the limit of the quotient

$$\frac{d(t + h) - d(t)}{h}$$

precise. (This will give rise to the concept of a derivative.)

• The process of computing a derivative is called differentiation. The opposite process is integration. The result of integration is an integral.

• Find formulas for computing derivatives and integrals.

• see lots and lots of applications.

• Math 2210 (Calc III) covers the Calculus of several (dependent or independent variables.)

• This semester we will follow the same schedule as most other 1210 sections. The Labs (mostly) will all have the same activities.