- Sit in your assigned seats. Make sure you are using the correct PRS unit to answer questions.
- Last Lecture
  - Free-body diagrams
- Today
  - Kinematics - describing 1D motion
  - Relative velocity (yes, more vectors!)
- Important Concepts
  - Change=derivative=slope
  - Think carefully about directions (changes the +/- sign)

Important Reminders

- Finish Mastering Physics # 2 tonight before 10pm
- Mandatory tutoring sessions start this week
- Office hours posted
- Pset # 2 due this Friday

Kinematics: Description of Motion

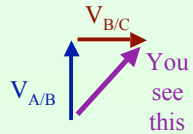
- All measurements require an origin, a coordinate system, and units
  - Next complication is "reference frame", the term used to describe the motion of observer
    - Constant velocity is OK, accelerated observer is not
- Basic definitions:
  - Position
    - Distance versus displacement
  - Velocity - change of position
    - Speed is the magnitude of velocity
  - Acceleration - change of velocity

Relative Velocity

- Basic concept:
  - Observer B sees a moving object A, and
  - Observer B is moving relative to observer C, so
  - What does observer C see for the motion of the object?
- Notation: use "wrt" to indicate "with respect to"

$$\vec{V}_{\frac{A \text{ wrt}}{C}} = \vec{V}_{\frac{A \text{ wrt}}{B}} + \vec{V}_{\frac{B \text{ wrt}}{C}}$$

- Example: A=ball, B=me, C=you



Key Kinematics Concepts

- Change=slope=derivative

$$v_x = \frac{dx}{dt} \qquad a_x = \frac{dv_x}{dt} = \frac{d^2x}{dt^2}$$

  - velocity is the slope of position vs t, acceleration is the slope of velocity vs t and the curvature of position vs t
- Even in simple 1D motion, you must understand the vector nature of these quantities
- Initial conditions
- All formulas have assumptions

One Important Special Case

Constant Acceleration = a

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$v = v_0 + a t$$

- Physics
- Initial conditions

Multi-body Kinematics Problems

- Need to use consistent coordinate system and origin for all objects
- Need to think carefully about directions (signs!)
- Need to think carefully about initial conditions, especially when things “start” at different times
- Write separate equations for each object
- Read problem carefully to understand the specific constraint to use to solve

Summary

- Kinematics provides a language to describe motion
- Basic relationship between position, velocity, acceleration (change=slope=derivative)
- Study special cases (like constant acceleration) but understand the assumptions that go into all formulas
- Position, velocity, and acceleration are ALL vectors and need to be manipulated using either arrows (qualitative) or components (quantitative)
- Directions (or signs in 1D) of position, velocity, and acceleration can all be different