Phys141 – Lecture 3 – Wed 9/7

Review Chapter 1: Basic tools of classical mechanics:

- Basic, standardized quantities for measurements:
  - Length, Mass, Time
- Dimensions of quantities
  - Conversion of units
  - Density – an example of derived dimensions
  - **Dimensional Analysis**
- **Common sense checks:**
  - **"are results reasonable"**
  - **Order of magnitude estimate**
- Uncertainty in measurement and calculation
  - Significant figures
  - Rounding

ToDo: Read Chapter 2.6; (Skip Chapter 2.7)
Read Chapter 3
Homework DUE FRIDAY (online and printout!)

Operations with Significant Figures – Multiplying or Dividing

Number of significant figures in the answer:
~ smallest number of significant figures of the quantities that are multiplied/divided.

Example: 25.57 m x 2.45 m = 62.6 m^2

- The 2.45 m limits your result to 3 significant figures

Operations with Significant Figures – Adding or Subtracting

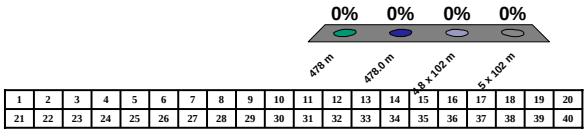
Number of decimal places in the result:
~smallest number of decimal places in any term in the sum.

Example: 135 cm + 3.258 cm = 138 cm

- The 135 cm limits your answer to the units decimal value

932m x 0.5 + 12m = ??

1. 478 m
2. 478.0 m
3. 4.8 x 10^2 m
4. 5 x 10^2 m



Rounding

Last retained digit is increased by 1 if the last digit dropped is 5 or above

Last retained digit remains as it is if the last digit dropped is less than 5

Do not round before you get to the final result

Example: Round the sum of 1001 contributions of $0.40 to the nearest $

- Final result of calculation: $400.40
- Rounded final result: $400
- Round each contribution: $0
  –> sum (rounded too early) is $0

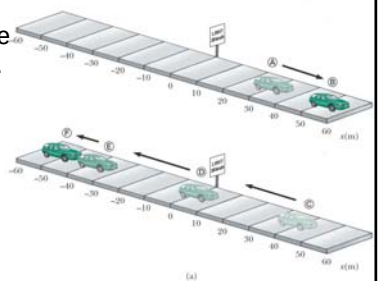
Chapter 2: Kinematics

- **Kinematics: Basic tools to characterize motion**

DEMO

Position

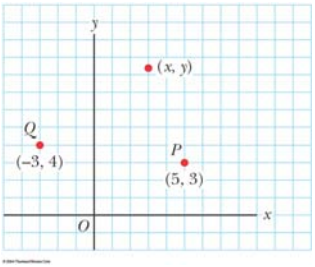
- Defined only relative to known reference.
- Term: "**frame of reference**"
- need to define
  1. origin
  2. one, two or three axes
  3. Measurement units



Movie Frame by Frame

Example Frame of reference: Cartesian Coordinate System

- rectangular coordinate system
- *x*- and *y* axes intersect at the origin
- Points are labeled (*x*,*y*)



Does the reference frame move?

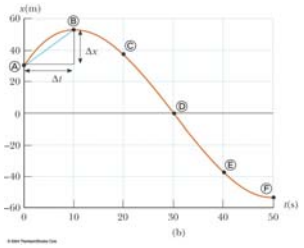
-Tablecloth Demo

Do the plates move or not? -> Depends on the reference frame

Generally: Measurements in Laboratory reference frame

Graphical representation: Position-Time Graph

- The position-time graph shows the motion of the "particle"
- **Active Figure2.01**
- **Demo**



Displacement

- Change in position from initial point x_i to final point x_f
  - Represented as Δx

    $\Delta x = x_f - x_i$
  - SI units?

Velocity

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

- Dimensions are length / time [L/T]
- The SI units are m/s
- **Average velocity**

$$v_{average} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{\Delta t}$$

Instantaneous Velocity

Mathematically: The limit of the average velocity for infinitesimally short times (Δt approaches zero)

$$v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

- The instantaneous velocity can be positive, negative, or zero

Velocity from position vs time graphs

- The slope of position vs time graph is the velocity
- Interactive Figure 

Instantaneous Speed

= magnitude of the instantaneous velocity

- scalar quantity (**positive** number - see chap. 3)
- same units as velocity

- Does your car show velocity or speed?

Average Speed

- Definition: Average speed = $\frac{\text{total distance traveled}}{\text{total time}}$

not the magnitude of the average velocity

You drive once all around the beltway and after one hour and 55 miles you arrive back in collage park.

- what is the average speed of the whole trip?
- What is the average velocity of the whole trip?
- what is the instantaneous velocity right before the Wilson bridge?

Acceleration

Rate of change of the velocity

- **Average acceleration:**

$$\bar{a}_x = \frac{\Delta v_x}{\Delta t} = \frac{v_{xf} - v_{xi}}{\Delta t}$$

- Dimensions $[L/T^2]$
- SI units m/s^2

Instantaneous Acceleration

Mathematical definition: Instantaneous acceleration is the limit of the average acceleration as Δt approaches 0

$$a_x = \lim_{\Delta t \to 0} \frac{\Delta v_x}{\Delta t} = \frac{dv_x}{dt} = \frac{d^2x}{dt^2}$$

Active Figure 2.10:

Active Figure 2.11 (practice yourself)

Useful equations

for constant acceleration a:

$$a(t) = a$$

$$v(t) = v_i + at$$

Need to know:
-Initial velocity v_i

$$x(t) = x_i + v_i t + \frac{1}{2} a t^2$$

Need to know:
-Initial position x_i
-Initial velocity v_i

Questionnaire answers – Which physics will you need?

Examples:

- Whatever physics is on the MCAT
- Calculating the movements of cells or chemicals
- Pathologist: how forces affect me – how they affected organisms in the past
- Quantum mechanics for physical chemistry

To Do

- Read Chapter 2.6; (Skip Chapter 2.7)
  Read Chapter 3
- short pre-class quiz
- Homework due Fri– online and hand in!