Grading:

- **Instructor:** Prof. Anthony Shoup (Tony)
- **Office:** rm 3164, FRH
- **Phone:** (949) 824-7291
- **Email:** shoup@uci.edu
- **Lecture times:** M W F 3:00 – 3:50
- **Lecture place:** PSLH 100
- **Office hours:** M W 10 to 11 am; T Th 1 – 2 pm; or by appointment
- **Text:** Principles of Physics 3rd edition by Serway & Jewett

Physics 3A: Basic Physics I

"I can only show you the door...
Your the one that has to walk through it."

Physics 3A: Basic Physics I

- **Course Objectives:**
  - Introduce "tools" to describe/analyze motion (kinematics) and its causes (dynamics)
  - Achieve this through solving many examples and homework problems!
  - Give homework a try (You have to walk through the door)
  - Ask questions at discussion
  - Ask questions at office hours (both mine and TAs')
  - Go to Physics Tutoring Center (rm 390 RH)
  (http://www.physics.uci.edu/NEW/instruction.shtml)

- **Grading:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly Quizzes</td>
<td>8x10 = 80</td>
</tr>
<tr>
<td>Midterm Exam (closed book)</td>
<td>100</td>
</tr>
<tr>
<td>Final Exam (closed book)</td>
<td>150</td>
</tr>
<tr>
<td>Total</td>
<td>330</td>
</tr>
<tr>
<td>Homework</td>
<td>9 x 2=18 extra credit</td>
</tr>
</tbody>
</table>

- **Straight scale:**
  - 90% to 100% = > A
  - 80% to 89% = > B
  - 70% to 79% = > C
  - 60% to 69% = > D
  - < 60% = > F
Physics 3A: Basic Physics I

Grading (continued):

• Makeup Policy:
  • Homework – no make-ups!
  • Quizzes – no make-ups!
• Midterm – Call me ahead of time (leave message)
• Final Exam – Call me ahead of time (leave message)
  (they tend to be harder)

• Re-grades:
  • Quizzes: Take to discussion TA
  • Midterm & Final: Take to me

Physics 3A: Basic Physics I

• Discussion sections:
  • Attendance is mandatory
  • Weekly Quiz
  • Attend assigned section only!
  • Low teacher-student ratio: Ask Questions!

• Homework:
  • Puts concepts and skills into practice
  • Try on your own first
  • Ask for help
  • Quiz problems directly from homework
  • Extra credit

Physics 3A: Basic Physics I

Schedule:

<table>
<thead>
<tr>
<th>Week #</th>
<th>Date</th>
<th>Topic</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>9/27-10/1</td>
<td>Intro, Vectors, Math</td>
<td>Ch. 1</td>
</tr>
<tr>
<td>#2</td>
<td>10/4-10/8</td>
<td>1-D Motion</td>
<td>Ch. 2</td>
</tr>
<tr>
<td>#3</td>
<td>10/11-10/15</td>
<td>2-D Motion</td>
<td>Ch. 3</td>
</tr>
<tr>
<td>#4</td>
<td>10/18-10/22</td>
<td>Newton’s Laws</td>
<td>Ch. 4</td>
</tr>
<tr>
<td>#5</td>
<td>10/25-10/29</td>
<td>Applications of Newton's Laws</td>
<td>Ch. 5</td>
</tr>
<tr>
<td>#6</td>
<td>11/1-11/5</td>
<td>Torque &amp; Equilibrium</td>
<td>Ch. 10.5 &amp; 10.6</td>
</tr>
<tr>
<td>#7</td>
<td>11/8-11/12</td>
<td>Work &amp; Energy</td>
<td>Ch. 6</td>
</tr>
<tr>
<td>#8</td>
<td>11/15-11/19</td>
<td>Potential Energy</td>
<td>Ch. 7</td>
</tr>
<tr>
<td>#9</td>
<td>11/22-11/26</td>
<td>Momentum &amp; Impulse</td>
<td>Ch. 8</td>
</tr>
<tr>
<td>#10</td>
<td>11/29-12/3</td>
<td>Collisions &amp; Review</td>
<td>Ch. 8</td>
</tr>
</tbody>
</table>

Physics 3A: Introduction

Units:

• Need units to communicate quantities to others
• Use SI (Systeme International) system of units
  • Length: meter (m) (defined as "distance traveled by light in vacuum during 1/299 792 458 second)
  • Mass: kilogram (kg) (defined as mass of a specific platinum-iridium alloy cylinder)
  (Mass is not same as weight!)
• Time: second (s) (9 192 631 770 times the period of oscillation of radiation of cesium atoms)
• Derived quantities are combinations of these
• Density: \( \rho = \frac{m}{V} \) m = mass, V = Volume
Physics 3A: Introduction

- Old British engineering system:
  - Length: foot (ft)
  - Mass: slug (sl)
  - Time: second (s)

- Conversion between systems (see Table A.1):
  - 1 ft = 0.304 m; 1 m = 3.281 ft
  - 1 kg = 6.852 x 10^-2 sl; 1 sl = 14.59 kg

(DO EXAMPLES)

Physics 3A: Introduction

- Numbers
  - Scientific Notation
    - Form: ± d.dd x 10^{dd}
    - Examples:
      - 1234000000 = 1.234 x 10^9
      - 0.0001234 = 1.234 x 10^-4
    - Speed of light:
      - c = 299 792 458 m/s => 2.99792458 x 10^8 m/s
  - Significant figures
    - Many times measured quantities are only known to a certain accuracy

Physics 3A: Introduction

- Significant figures (continue)
  - Significant figures indicate the level of uncertainty of a quantity
  - Only keep the number of digits in the quantity which you are "sure of"
  - Digits which are significant:
    - Any non-zero digits
    - Any zeros between non-zero digits
    - Any zeros not used only as "place holders"
  - In scientific notation, all digits are significant

Physics 3A: Introduction

- Significant figures (continue)
  - Rules for combining numbers
  - Multiplication and division
    - Number of significant figures in result is same as lowest number of significant figures in numbers being multiplied
    - 3.1415 x 29000 = 91103.5 or 91000 ?
  - Addition and subtraction
    - Number of decimal places in result is same as that of the term with the smallest number of decimal places
    - 3.1415 - 3.14 = 0.0015 or 0.00 ?
Physics 3A: Introduction

- Dimensional Analysis
- "Dimension" of a quantity is its "nature"
- Fundamental dimensions are:
  - Length (L)
  - Mass (M)
  - Time (T)
- Examples of dimensions of other quantities:
  - Displacement: \( [d] = L \)
  - Velocity: \( [v] = L/T \)
  - Acceleration: \( [a] = L/T^2 \) (do example 1.3)
  - Density: \( [\rho] = m/V = M/L^3 \)


Physics 3A: Introduction

- Coordinate Systems
- Needed to specify the location of an object in space
- Systems consist of:
  - Fixed reference point (origin O)
  - Set of fixed axes with directions and scale (units too!)
  - Instructions on how to label/locate a point relative to the origin
- Examples
  - Cartesian coordinate system (rectangular system)
  - Plane polar coordinate system


Physics 3A: Introduction

- Cartesian System (2-D)
  - Coordinates: \((x – \text{horizontal}, y – \text{vertical})\)


Physics 3A: Introduction

- Cartesian System (3-D)
  - Coordinates:
    \((x – \text{into/out of screen}, y – \text{horizontal}, z – \text{vertical})\)


Diagram of Cartesian System (2-D) with points labeled:

- Q \((-6,4)\)
- P \((9,6)\)
- R \((-15,-5)\)
- O \((0,0)\)

Diagram of Cartesian System (3-D) with points labeled:

- (x,y,z) \((x,y,z)\)
- \((3,-4,5)\)
Physics 3A: Introduction

- Plane polar system:

\[ r \cos(\theta) = x \]
\[ r \sin(\theta) = y \]

- \( x, y \rightarrow r, \theta \)

\[ \tan(\theta) = \frac{y}{x} \]
\[ r = \sqrt{x^2 + y^2} \]

- Two vectors are equal if their magnitudes are equal and they point in the same direction. Which of these vectors are equal?

\[ \text{B = D = E; C = F} \]

Also note: \( E = -G \)

Physics 3A: Introduction

- Vectors and Scalars
  - Scalar - quantity that has a magnitude ("size") only
  - Examples: temperature, mass, energy, pressure.
  - Vector - quantity that has a magnitude and direction
  - Examples: displacement, velocity, acceleration, ...

\[ \text{Displacement} \]

(Do demo!)

Physics 3A: Introduction

- Vector Addition
  - Just like scalars, two vectors must have the same units to be added together
  - Graphical (triangle) method:

\[ a + b = \text{???} \]

- Draw vector \( a \) to scale and in proper direction
- Draw vector \( b \) to same scale and in proper direction with its tail at the head of \( a \)
- Draw the vector sum \( r \) (resultant vector) by drawing an arrow from the tail of \( a \) to the head of \( b \)
Physics 3A: Introduction

- **Example:**
  - Draw \( a \)
  
  - Draw \( b \) to same scale with tail at head of \( a \)
  
  - Draw the vector sum \( r \) from tail of \( a \) to head of \( b \)

  \[ r = a + b \]

  (do example 1.4)

**Physics 3A: Introduction (cont)**

- **Graphical (parallelogram) method:**
  - Place vectors' tails together (1)
  - Form parallelogram (2)
  - Resultant vector is diagonal of parallelogram (3)

**Physics 3A: Introduction**

- **Vector Addition (cont)**
  - Commutative law:
    - \( a + b = b + a \)

- **Associative law:**
  - \( a + (b+c) = (a+b) + c \)

**Physics 3A: Introduction**

- **Vector Subtraction**
  - Form negative of second vector
    - negative of \( b \) (-\( b \)) has same magnitude as \( b \) but opposite direction
    - note: \( b + (-b) = 0 \)

  - then add
    - \( a - b = a + (-b) \)
Physics 3A: Introduction

- How do you add a scalar and a vector?
  - Example:
    
    \[
    \text{speed (m/s)} \quad s + v = ? \quad \text{velocity (m/s)}
    \]

- What is:
  
  \[
  \text{acceleration} \quad a + v = ? \quad \text{velocity}
  \]

Physics 3A: Introduction

- Multiplication (cont)
  - Vector times a Vector
    - Two ways:
      - Vector x Vector = Scalar  (scalar product)
        \[
        a \cdot b = |a| |b| \cos(\theta)
        \]

      - Vector x Vector = Vector  (vector product)
        \[
        a \times b = |c| = |a| |b| \sin(\theta)
        \]

        “cross product” = a x b
        “right hand rule”

Physics 3A: Introduction

- Multiplication
  - Scalar times a Vector
    - if scalar is positive then it only changes vector’s magnitude
    - if scalar is negative then it changes magnitude and reverses vector’s direction

  - Examples:
    - b = 3 * a
    - b = \frac{1}{2} * a
    - b = -2 * a

Physics 3A: Introduction

- Vector Components
  - Graphical addition of vectors not very accurate or easy.
  - Easier and accurate method to "add" vectors is to "add" their components.
  - We can resolve a vector into components by "projecting" the vector onto a coordinate axis.

- Scalar time a Vector
  - if scalar is negative then it changes magnitude and reverses vector's direction

- Examples:
  - a
  - b
  - b = 3 * a
  - b = \frac{1}{2} * a
  - b = -2 * a
Physics 3A: Introduction

- From figure and trig. we see:
  \[
  \cos(\theta) = \frac{A_x}{A} \quad \tan(\theta) = \frac{A_y}{A} \\
  \sin(\theta) = \frac{A_y}{A} \quad A^2 = A_x^2 + A_y^2
  \]

- so we can compute relationships between components, magnitude and direction of a vector:
  \[
  A_x = A \cos(\theta) \quad A = \sqrt{A_x^2 + A_y^2} \\
  A_y = A \sin(\theta) \quad \theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)
  \]

- To simplify expressing vectors using their components, we introduce "unit vectors":
  - Vectors with magnitudes of one and only specify a direction
  - \(|i| = |j| = |k| = 1\)

- To express a vector with \(i, j, k\) and the vector’s components, use:
  \[
  A = A_x i + A_y j
  \]

- In 3-D: (unit vector notation)
  \[
  A = A_x i + A_y j + A_z k
  \]

- Component-wise vector addition
  - Consider:
    \[
    R = A + B \\
    A = A_x i + A_y j + A_z k \\
    + B = B_x i + B_y j + B_z k \\
    R = R_x i + R_y j + R_z k
    \]
  - where:
    \[
    R_x = A_x + B_x \\
    R_y = A_y + B_y \\
    R_z = A_z + B_z
    \]
Physics 3A: Introduction

Here are the formula:

**Dot Product:**

\[ \mathbf{A} \cdot \mathbf{B} = |\mathbf{A}| |\mathbf{B}| \cos(\theta) = A_x B_x + A_y B_y + A_z B_z \]

**Cross Product:**

\[ \mathbf{C} = \mathbf{A} \times \mathbf{B} = \]

\[ (A_y B_z - A_z B_y)\hat{i} + (A_z B_x - A_x B_z)\hat{j} + (A_x B_y - A_y B_x)\hat{k} \]