Physics 247:
A Modern Introduction to Physics

Website: http://uw.physics.wisc.edu/%7Edjchung/phys247/phys247.html

LECTURE 1: A General Introduction

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What is Physics?

- Definition of physics

  abstract: Study of fundamental patterns of nature

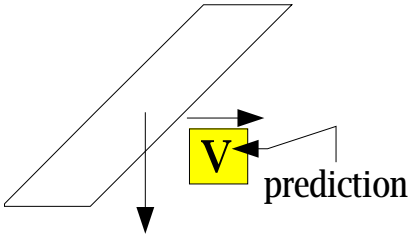
  simplified: Study of evolution and interaction of “stuff”, such as particles, forces, and vibrations.

- **All** other sciences and engineering have at least an implicit dependence on physics: e.g.
  - Chemistry: Newton's laws (c. 1687), Maxwell Eqs. (c. 1864), statistical mechanics/thermodynamics (c. 1877), quantum mechanics (c. 1925)
  - Biology: mostly chemistry, Newton's laws (c. 1687)
  - Electrical Engineering: Maxwell Eqs. (c. 1864), chemistry
  - Mechanical Engineering: Newton's laws (c. 1687), statistical mechanics/thermodynamics (c. 1877)

Skills of Physicists

- All Sciences: Ask and answer relevant questions.
  - Create approximate models that can predict!

    e.g. If the wing span of of particular geometry is x
    and the weight of airplane is y, how fast must the
    airplane go before the it can take off into the air?
    - Model:

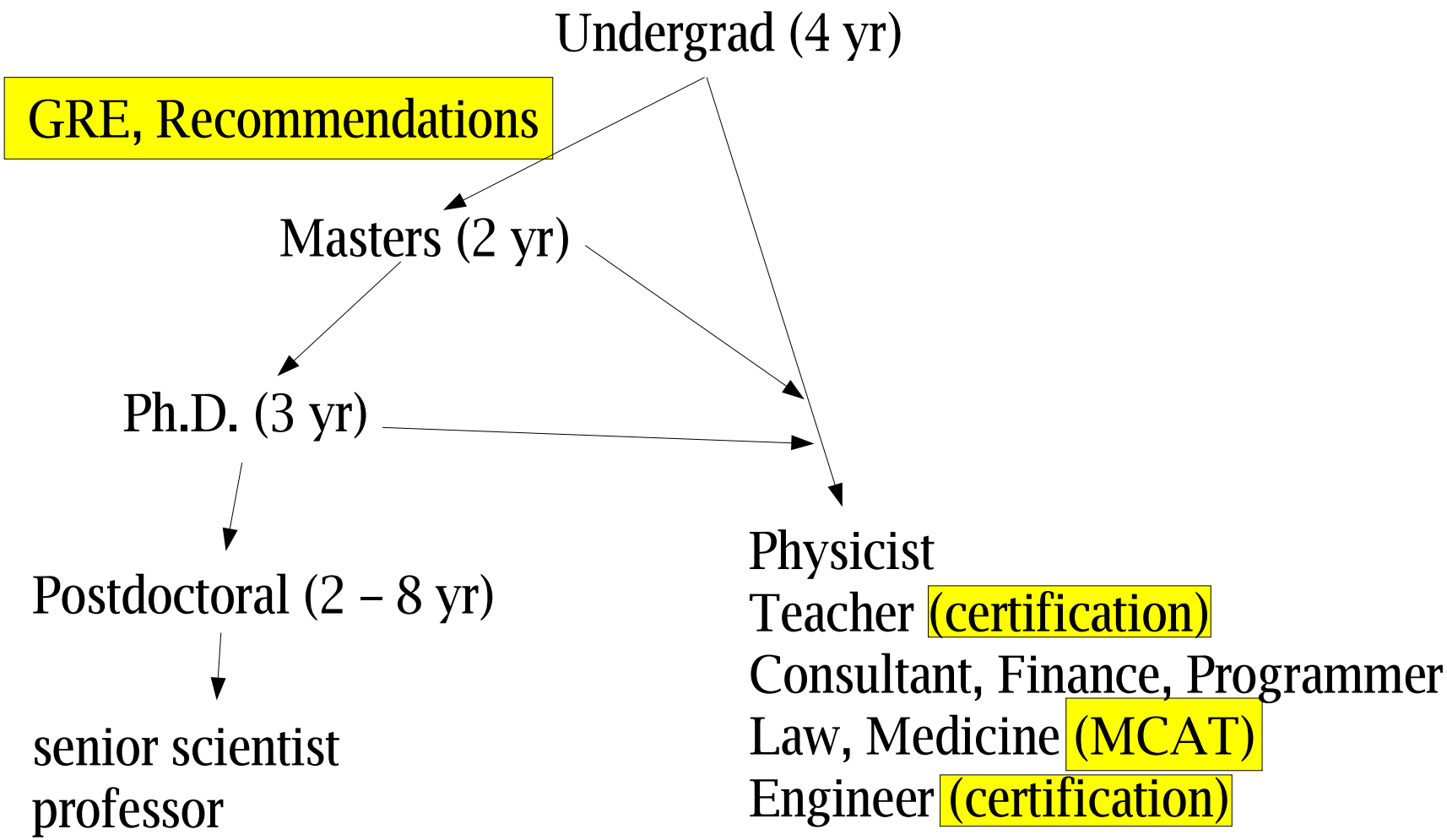


$\vec{F}_g = -y\,\vec{e}$

Leading approximation:
a) neglect wind resistance
b) All lift comes from wing
c) ½ reaction lift +
½ Bernoulli

- Physics:
  - Most use of mathematics (because most precise language)
  - Largest # of phenomena explained by smallest # of principles.
    (i.e. focus on derivations from first principles)

Typical Physics Major's Career Path



Example Jobs

- Professor:
  - Teach physics at the most advanced level; Pass the torch
  - Research: Find new principles governing nature;

    Expand what human beings know
- High School Teacher:
  - Build future of America/World
    - Our economy wins if people are science literate
    - Do you want people designing computers, cars, airplanes, medical equipment to have a good foundation in physics?
  - More direct impact on larger population (very rewarding)
  - Lot's of money and vacation time

How Is This Course Relevant to Me?

- Basic physics: Leading Approximation Physics
  - Give intuition for future studies in physics (baby exploring world)
  - Equalize the different levels of high school preparation:
    - better prepared from HS -> less work
    - less prepared from HS -> more work
  - Appreciation for the "approximation" comes after you learn the "rigorous" physics in more advanced courses
- Exams (such as GRE, MCAT, etc.) focus on skills taught in this course.
- 247 – Mechanics + special relativity, 248 – E&M and stat mech, 249 – Quantum and survey of subfields

Topic Details

1. Space-time Coordinate Newtonian Dynamics
   (a) Measurement + 1D (DC .5 week) TM 1+2
   (b) 2D & 3D motion (DC 1 week) TM 3
   (c) Newton's laws (DC 2 weeks) TM 4 + 5
2. Space-time Coordinates in Special Relativity
   (a) Relativistic motion (GS 1 week) TL Ch 1; TM R-1 R-6
   (b) Lorentz transformations (GS 2 weeks) TL Ch 1
3. Newtonian Energy-momentum space
   (a) Work and Energy (GS 1 week) TM 6+7
   (b) Conservation Laws and Multiple Particles (DC 1 weeks) TM 8+9
   (c) Rotation and Angular Momentum in spherically symmetric systems (DC 2 weeks) TM 9+10
4. Special-relativistic conservation laws: Energy-Momentum Conservation (GS 2 weeks) TL Ch 2; TM R-7
5. Static Equilibrium (GS 1.5 weeks) TM 12
6. Gravity (DC 1 lecture) TM 11

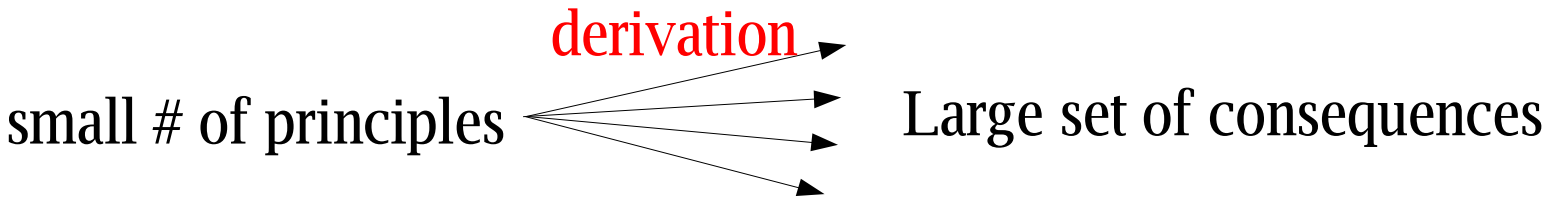
Aimed Approach

Given the variety of HS preparations:

- During lectures:
  - One easy example
  - One medium difficulty example
- Homework:
  - easy - medium difficulty example
  - difficult example (can be more difficult than in lectures)
  - Help is always available
    - Discussion sections
    - Office hours

Recommendation for Study

1. Skim through the assigned reading to get overview.
2. Read again, this time slowly, and work through all of the equations.



3. Participate in the lecture.
4. Work on homework covered in reading and lecture.
5. Question during discussion sections and office hours.
6. Review all answers to homework before turning it in.

Recommended Attitude in Physics

- Mathematics is only a language. Physics is not intrinsically about formulae, just as Shakespeare is not about the English grammar.
- Ask questions to yourself, your friends, professors, etc. "Too many" Q's are much better than no Q's. (Win points for recommendations!)
- Take limits of all your answers to "understand" the physics.
- Learn to respectfully disagree. Take nothing as true unless you are convinced. Don't make your friends feel bad by being rude.
- Your arguments are as good as anyone else's as long as they are logical. There is an infinite number of "right" answers.
- Mistakes are good: learn from them! Don't be afraid!
- Get plenty of sleep! If sleep deprived, perhaps take fewer courses.
- Use dimensional analysis to remember physics and avoid errors.

Studying for Exams

- Based on all the homeworks, try to make up your own exam that reflects the material covered.
- This can be done individually or in groups.
- There is no better way to reinforce understanding than by teaching someone else.
- Be able to work out practice problems from beginning to the end by yourself without help.

Policies

/uw.physics.wisc.edu/~djchung/phys247/phys247.html

Course Web page: /uw.physics.wisc.edu/~djchung/phys247/phys247.html
Homework assignments and solutions will be posted on this web page, as will other announcements.

Professors: Daniel Chung (danielchung@wisc.edu) and Gary Shiu (shiu@physics.wisc.edu).

Teaching Assistant: Ryan Gavin (rgavin@wisc.edu)

Office Hours: Daniel Chung (5207 Chamberlin, TW 10-11 AM), Gary Shiu (5279 Chamberlin, TW 2-3 PM), Ryan Gavin (4257 Chamberlin, MT 4:30-5:30 PM) Feel free to make appointments outside of these hours.

Prerequisite: We will use calculus throughout the course. We are assuming that students have completed at least one semester of calculus and are currently taking second semester calculus.

Text: "Modern Physics" by Llewellyn and Tipler
"Physics for Scientists and Engineers" by Tipler and Mosca.
(These texts will be used as well for 248 and 249. Only Volume 1 of Tipler and Mosca will be used for 247.)

Grading: 20% homework, 20% laboratory, 20% final exam, and 40% for the sum of the three midterms. This last 40% will be 2/5 your best midterm, 2/5 your second best, and 1/5 your third best (for those who are counting, that 16%, 16%, and 8% of the total).

Homework: Homework will be due on the announced days in the physics 247 mailbox by 5pm. Late homework is not accepted. We will drop your lowest homework score. Each homework problem is worth 0-3 points and will be graded according to the following scale: 0 hmmm, 1 tried but little progress, 2 on the right path but significant errors, 3 correct or only minor errors.

Lab Lab grading policy will be determined by Ryan. A bound quadrille notebook is required for laboratory write-ups.

Midterms The three 50 minute midterm exams will be on October 4, November 1, December 6 during lecture.

Chapter 1 of TM
System of Measurements

Standard Units

- Physics is about relationships of measurements.
- Measurements have units.
- Newtonian (also called classical) Mechanics:
  - Length (meters), Time (seconds), Mass (kg)
  - second = frequency of transition of an atom
  - meter = distance light travels in vacuum in 1/299,729,458 sec.
  - kg = defined to be the inertia of a standard object (internationally agreed upon) made of platinum-iridium

Matching Units

- Dimensional analysis = matching units
- It can be used to avoid errors/ guess answers:

e.g. a = acceleration; v = speed

$$[a] = m/s^2$$

$$[v] = m/s$$

Is the speed of an object that has accelerated uniformly through a distance d is either $v^2 = 2ad$ or $v^2 = (2ad)^2$. Which one?

Another Example

An object on the end of a string moves in a circle. The force exerted by the string has units of $kg\ m/s^2$ and depends on the mass of the object, its speed, and the radius of the circle. What combination of these variables gives the correct dimensions?

Next Lecture: Chapter 2 of TM