LECTURE 00: INTRODUCTION

WARM UP: Name game:

Groups of about 6-8.
- Name.
- Major.
- Something interesting and/or why here.
- 1 group member introduce entire group to class.

http://www.fliphysics.com/ph201-w17/

Hi! Welcome to PH201, general physics with a focus on Newtonian mechanics. Naturally the first question many ask when taking their first physics course is, “what the heck IS physics?”. Often it is described as, the study of how the universe behaves. This definition does not do a very good job of narrowing down what physics is, and unfortunately it is true that physics does not have well defined boundaries of what it encompasses. But on the flip side, this ill -defined boundary allows virtually anyone to discover how parts of physics can help them better understand their passions. So whether your passion includes stars, atoms, rockets, muscles, hearts, medicine, building bridges, cars, etc, physics has something to offer. This vastness of topics that can be enhanced through the knowledge of physics should be an indication that physics also overlaps with many other majors, including but not limited to chemistry, biology, engineering, and mathematics.

So, does this mean we have only 10 weeks to basically cover all of life, the universe, and everything? That would be quite the tall order indeed. Even including the succeeding 2 terms of physics, PH202 and PH203, we will not be able to cover everything. Thus we will limit our scope to select topics in physics throughout this 3 term physics series. Much of this term will deal with Newtonian mechanics, spilling over into part of next term where we will then diffuse into a bit of fluid mechanics and thermodynamics, before we conclude our studies with electricity and magnetism in the final 3rd term.

Before we dive into our studies, it is important to stand back to get a larger scope of what we are about to tackle and where it fits into life, the universe, and everything. First, at the most fundamental level, almost every subject deals with the same underlying question, "how does my system evolve in time?". Think about this for a moment. The majority of what we have been studying in chemistry, biology, physics, history, finance, etc… was motivated by this very question. As we study Newtonian mechanics this term, hopefully you will take a step back every now and then and appreciate how we can almost always trace back to this one question.

But perhaps your question at the moment is, what is Newtonian mechanics? Well, physics can be broken down into various different realms including but not limited to Newtonian mechanics, thermodynamics, statistical mechanics, electrodynamics, special relativity, quantum mechanics, and quantum field theory.

SPECIAL RELATIVITY:
When: 1905
Who: Albert Einstein
What: Correction to classical mechanics (both Newtonian and Electrodynamics) to account for objects with velocity near the speed of light (very fast moving particles larger than roughly 10^{-6} m in size.).

QUANTUM MECHANICS:
When: 1920s
Who: Niels Bohr, Werner Heisenberg, Erwin Schrödinger, et al.

What: Correction and addition to classical mechanics for objects that are extremely small (near the size of atoms).

QUANTUM FIELD THEORY:
When: 1930-1940
Who: Paul Dirac, Wolfgang Pauli, Richard Feynman, Julian Schwinger, et al.
What: Union of special relativity and quantum mechanics (very fast moving small stuff smaller than roughly 10^{-6} m in size).

THERMODYNAMICS:
When: 1800s
Who: James Joule, Lord Kelvin, Max Plank, Maxwell Boltzmann, Hermann von Helmholtz, Nicolas Carnot, et al.
What: Central concept is temperature. Macroscopic explanation of energy transfers via heat.

STATISTICAL MECHANICS:
When: 1860-1900
Who: James Maxwell, Ludwig Boltzman, Josiah Gibbs
What: Models macroscopic observations via a microscopic and probabilistic approach.

ELECTRODYNAMICS:
When: 1800s
Who: James Maxwell, Michael Faraday, Jean-Baptiste Biot, Felix Savart, et al.
What: Describes interactions between electric charges, currents, electric and magnetic fields.

NEWTONIAN MECHANICS:
When: 17th century
Who: Isaac Newton
What: Describes interactions (introduction of forces) between objects, and their subsequent motions. (slow moving particles larger than roughly 10^{-6} m in size)

NEWTONIAN MECHANICS CONCEPT MAP FOR PH201

GENERAL REVIEW:

Hopefully everyone taking this course is already familiar with significant figures, thus a detailed discussion should not be necessary. If you wish to brush up on the concept there are many great online resources. One such example of an online resource is the videos found over at flipping physics, (intro to sig figs, working with sig figs). Our lab manual introduction will also include a short recap of significant figures.

For this class, a good rule of thumb is the following. Answer questions with correct significant figures if stated, otherwise answer with 3 significant figures, however, while doing calculations keep at least (more the better) 4 significant figures (5 if you are using powers or exponentials, again more the better).

I recommend using scientific notation as much as possible.

EX: SPEED OF LIGHT ≡ C

EXACT!! $c = 299{,}792{,}458$ m/s

3 SIG FIGS $c \approx 3.00 \times 10^{8}$ m/s

3 sig figs $c \approx 3.00 \times 10^8$ m/s

Using scientific notation can help you do quick estimates of what a calculation is by exploiting the communitive property of multiplication.

EXAMPLE: Multiply the following two numbers without a calculator. (3 x 10^4)(2 x 10^5).

$$(3 \times 10^4)(2 \times 10^5) = (3)(10^4)(2)(10^5)$$
$$= (3)(2)(10^4)(10^5)$$
$$= (6)(10^9)$$
$$= 6 \times 10^9$$

PRACTICE: Given the equation, distance = speed * time, how far does light travel in 1.3 nanoseconds? (nano is a prefix for 10^{-9})

1. 3.9 x 10^1 m
2. 3.9 x 10^{-1} m
3. 3.9 x 10^{-72} m
4. 4.3 x 10^1 m
5. 4.3 x 10^{-1} m
6. 4.3 x 10^{-72} m

TIPS FOR SUCCESS

Activity read/watch the assigned material before class. This differs from passive reading/watching, which we often do while pleasure reading/watching. Active reading/watching involves "talking" to the material; take notes, identify and label sentences/examples that don't make sense, write down questions that arise while engaging with the material, take note of (i.e. write down) those "ah HA" moments when something clicks while reading/watching.

Activity engage in class. Honestly attempt all practice problems when presented to you in class. Ask questions when confused, or even when you are not confused but are interested in the material.

After class re-do the in-class practice problems. Attempt to do the problems again without the solutions in front of you, but nearby in case you get stuck for too long. Often times I see students do a problem once and never revisit it. Problems are written/chosen to highlight certain aspects of the student learning outcomes of this course; "finishing" the problem once does not signify that outcome is truly met if assistance was provided during the first attempt. Practicing the problem without any help, multiple times, until you truly understand every aspect of the problem will solidify your understanding.

After class re-read/re-watch the assigned material for a deeper insight into the topic. This follows along the same lines of practicing problems multiple times. Almost no one is able to truly understand/learn anything by only looking at the material once.

Re-do homework problems as often as possible. Are you picking up on a theme yet?

Work with a group on homework problems. Explaining new topics and listening to peers is an invaluable tool. Communication with others in written and verbal forms is fundamental in almost any future endeavor that you will pursue.

Attempt to make a personal connection with the material presented in this course. Physics attempts to model the world around us. As pedagogical tools to help illustrate the fundamental concepts, we often will use "boxes", "inclines", "objects", etc... Take a good bit of time at the end of every week to reflect on what concepts you have learned, and try to connect those concepts to activities in your life. For example, tracking the motion of an object via kinematics is an abstract concept that, on the surface, probably does not interest you. However, if you like to golf, try relating kinematics to your typical golf shot. You will hold onto the learned material longer by relating core concepts to things that resonate with you. This process will also hopefully allow you to appreciate how physics is everywhere in your life, giving you motivation to actively engage in physics for not only this term, but the rest of your life.