PHYS 1443 – Section 003
Lecture #2

Monday, Jan. 25, 2021

*Dr. **Jaehoon Yu***

- How to study for this course?
- Brief history of physics
- Standards and units
- Estimates

Today's homework is homework #2, due 11pm, Tuesday, Feb. 2!!

Announcements

- Homework registration
  - 85/96 registered! Impressive! 71/85 completed the submission!
  - The deadline and the freebee homework are 11pm tonight!!
  - You need my approval to enroll and need to move quickly otherwise you will not have enough time to get the freebee HW!! Remember all HW carry the same weight!
- Quiz at the beginning of the class this Wed., Jan. 27
  - Appendix A1 – A9 and what we've learned today (CH1 – 3 or 4?)!
  - BYOF: You may bring a one 8.5x11.5 sheet (front and back) of **handwritten** formulae and values of constants for the exam
  - No derivations, word definitions, setups or solutions of any problems, figures, pictures, diagrams or arrows, etc!
  - No additional formulae or values of constants will be provided!
  - Must email me the photos of front and back of the formula sheet, including the blank at jaehoonyu@uta.edu no later than **12:00pm the day of the test**
    - The subject of the email should be the same as your file name
    - File name must be FS-Q1-LastName-FirstName-SP21.pdf
    - Once submitted, you cannot change, unless I ask you to delete part of the sheet!

Basic Rules for Online Exams

- All quizzes and exams will be online on Quest, the same system as your online homework
- Academic integrity is very important to keep the system the fairest to all
  - We all have to work together to maintain the integrity!
- Leave the camera ON showing you and UNMUTE the mic at all times
- If you have questions, type into the zoom chat window to me
- POWER OFF your phone, iPADs and any other computing devices except for the computer you take exam with
- Quit all other applications and web pages, except zoom and the Quest
- Have your calculator, formula sheet and clean scrap sheets out
- Strongly suggest to write down the answers before entering
- Send me the photos of the front and back of your formula sheet no later than 2.5 hours prior to the exam (E)/quizzes (Q)
  - File name must be FS-Q1-LastName-FirstName-SP21.pdf

Special Project #1 for Extra Credit

- Find the solutions for $yx^2-zx+v=0$ ➔ 5 points
  - x is the unknown variable, and y, z and v are constant coefficients!
  - You cannot just plug into the quadratic equations!
  - You must show a complete algebraic process of obtaining the solutions!
- Derive the kinematic equation $v^2 = v_0^2 + 2a(x - x_0)$ from first principles and the known kinematic equations ➔ 10 points
- You must **show your OWN work in detail** to obtain the full credit
  - Must be **handwritten** and in much more detail than in this lecture note!!!
  - Please do not copy from the lecture note or from your friends. You will all get 0!!
  - BE SURE to show all the details of your own work, including all formulae, proper references to them and explanations
- Due at the beginning of the class 1:00pm Monday, Feb. 1 on Canvas
  - File name must be: SP1-LastName-FirstName-SP21.pdf

What do we want to learn in this class?

- Physics is everywhere around you.
- Skills to understand the fundamental principles that surrounds you in everyday lives…
- Skills to identify what laws of physics applies to what phenomena and use them appropriately
- Understand the impact of physical laws and apply them
- Learn skills to think, research and analyze observations.
- Learn skills to express observations and measurements in mathematical language
- Learn skills to express your research in a systematic manner in writing
- But most importantly building up the confidence in your physics ability and to take on any challenges laid in front of you!!

Even more importantly, let us have a lot of FUN!!

Specifically, in this course, you will learn…

- Fundamentals and concepts of mechanics
  - Vector and scalar quantities
- Concepts of physical quantities that describe motions, such as velocity, speed, acceleration, etc
- Use of kinematic equations to describe motions
- Concepts of force, energy and momentum and their conservation laws
- Techniques to use conservation laws for motions
- Rotational motions and Equilibrium conditions
- Fluid and wave motions and thermodynamics
- Focus on relevance of these concepts for everyday lives

How to study for this course?

- Keep up with the class for comprehensive understanding of materials
  - Come to the class and actively participate in the discussions and problems solving sessions
  - Follow through lecture notes, keeping in mind these notes alone are insufficient
  - Work out example problems in the book yourself without looking at the solution
  - Have many tons of fun in the class, asking lots of questions!!!!!
- Keep up with the homework to put the last nail on the crate
  - One can always input the answers as you solve problems. Do NOT wait till you are done with all the problems.
  - Form a study group and discuss how to solve problems with your friends, then work the problems out yourselves!
- Prepare for upcoming classes
  - Read the textbook for the material to be covered in the next class
- The extra mile
  - Work out additional problems in the back of the book starting the easiest problems to harder ones

Why do Physics?

Exp. {
- To understand nature through experimental observations and measurements (**Research**)

Theory {
- Establish limited number of fundamental laws, usually with mathematical expressions
- Predict the nature's course

⇒Theory and Experiment work hand-in-hand

⇒Theory works generally under restricted conditions

⇒Discrepancies between experimental measurements and theory are good for improvements

⇒To improve our everyday lives, even though some laws can take a while till we see them amongst us

Brief History of Physics

- AD 18th century:
  - Newton's Classical Mechanics: A theory of mechanics based on observations and measurements
- AD 19th Century:
  - Electricity, Magnetism, and Thermodynamics
- Late AD 19th and early 20th century (Modern Physics Era)
  - Einstein's theory of relativity: Generalized theory of space, time, and energy (mechanics)
  - Quantum Mechanics: Theory of atomic phenomena
- Physics has come very far, very fast, and is still progressing, yet we've got a long way to go
  - What is matter made of?
  - How do matters get mass?
  - How and why do matters interact with each other?
  - How is universe created?

Terminologies: Models, Theories and Laws

- Models: An analogy or a mental image of a phenomena in terms of something we are familiar with
  - Thinking light as waves, behaving just like water waves
  - Often provide insights for new experiments and ideas
- Theories: More systematically improved version of models
  - Can provide quantitative predictions that are testable and more precise
- Laws: Certain concise but general statements about how nature behaves
  - Energy conservation
  - The statement must be found experimentally valid to become a law
- Principles: Less general statements of how nature behaves
  - Has some level of arbitrariness

Needs for Standards and Units – I

- Physics is based on precise measurements and comparisons
- A rule for how things are measured and compared is essential
- Need experiments to establish the units of such measurements
- Precise measurement is necessary for practical uses and for fully understanding the rules of nature
- Units define a unique name assigned to the measure of the given quantity
  - Consistency is crucial for physical measurements and comparisons
  - The same quantity measured by one must be comprehendible and reproducible by others
  - Practical matters contribute

Needs for Standards and Units – II

- Seven fundamental quantities for physical measurements
  - Length, Mass, Time, Electric Current, Temperature, the Amount of substance and the Luminous intensity
  - All other physical quantities can be derived from these
- A system of unit called **SI** (*System Internationale*) was established in 1971
- The three base quantities relevant for this course are
  - **Length** in meters (m)
  - **Mass** in kilo-grams (kg)
  - **Time** in seconds (s)
- These scales are called the human scales

Definition of Three Relevant Base Units

SI Units	Definitions
1 *m (Length)* = *100 cm*	One meter is the length of the path traveled by light in vacuum during the time interval of 1/299,792,458 of a second.
1 *kg (Mass)* = *1000 g*	It is equal to the mass of the international prototype of the kilogram, made of platinum-iridium in International Bureau of Weights and Measure in France.
1 *s (Time)*	One second is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the Cesium 133 (C^{133}) atom.

- *There are total of seven base quantities (see Appendix A)*
- *There are prefixes that scales the units larger or smaller for convenience (see T.1-2 pg. 2)*
- *Units for other quantities, such as Newtons for force and Joule for energy, for ease of use*

International Standard Institutes

- International Bureau of Weights and Measure http://www.bipm.fr/
  - Base unit definitions: http://www.bipm.fr/enus/3_SI/base_units.html
  - Unit Conversions: http://www.bipm.fr/enus/3_SI/
- US National Institute of Standards and Technology (NIST) http://www.nist.gov/

SI Base Quantities and Units

Quantity	Unit	Unit Abbrevation
Length	Meter	m
Time	Second	s
Mass	Kilogram	kg
Electric current	Ampere	A
Temperature	Kelvin	K
Amount of substance	Mole	mol
Luminous Intensity	Candela	cd

- *There are prefixes that scales the units larger or smaller for convenience (see pg. 9)*
- *These simplifies the expression of numbers: 20,000,000,000 bytes → 20GB*
- *Pick all the base units! (Poll 3)*

Prefixes, expressions and their meanings

Larger

- deca (da): 10^{1}
- hecto (h): 10^{2}
- kilo (k): 10^{3}
- mega (M): 10^{6}
- giga (G): 10^{9}
- tera (T): 10^{12}
- peta (P): 10^{15}
- exa (E): 10^{18}
- zetta (Z): 10^{21}
- yotta (Y): 10^{24}

Smaller

- deci (d): 10^{-1}
- centi (c): 10^{-2}
- milli (m): 10^{-3}
- micro (μ): 10^{-6}
- nano (n): 10^{-9}
- pico (p): 10^{-12}
- femto (f): 10^{-15}
- atto (a): 10^{-18}
- zepto (z): 10^{-21}
- yocto (y): 10^{-24}

How do we convert quantities from one unit to another?

Unit 1 = Conversion factor X Unit 2

1 inch	2.54	cm
1 inch	0.0254	m
1 inch	2.54×10^{-5}	km
1 ft	30.3	cm
1 ft	0.303	m
1 ft	3.03×10^{-4}	km
1 hr	60	minutes
1 hr	3600	seconds
And many	More	Here….

Examples for Unit Conversions

- Ex: An apartment has a floor area of 880 square feet (ft^2). Express this in square meters (m^2).

What do we need to know?

$$880\ ft^2 = 880\ ft^2 \times \left(\frac{12\ in}{1\ ft}\right)^2 \left(\frac{0.0254\ m}{1\ in}\right)^2$$

$$= 880\ ft^2 \times \left(\frac{0.0929\ m^2}{1\ ft^2}\right)$$

$$= 880 \times 0.0929\ m^2 \approx 82\ m^2$$

Ex: Where the posted speed limit is 55 miles per hour (mi/h or mph), what is this speed (a) in meters per second (m/s) and (b) kilometers per hour (km/h)?

$$1\ mi = (5280\ ft)\left(\frac{12\ in}{1\ ft}\right)\left(\frac{2.54\ cm}{1\ in}\right)\left(\frac{1\ m}{100 cm}\right) = 1609\ m = 1.609\ km$$

(a) $55\ mi/h = (55\ mi)\left(\frac{1609\ m}{1\ mi}\right)\left(\frac{1}{1\ h}\right)\left(\frac{1\ h}{3600\ s}\right) = 25\ m/s$

(b) $55\ mi/h = (55\ mi)\left(\frac{1.609 km}{1\ mi}\right)\left(\frac{1}{1\ h}\right) = 88\ km/hr$

Uncertainties

- Physical measurements have limited precision, however good they are, due to:

Stat.{
  - Number of measurements (Normally scales by $1/\sqrt{N}$)

Syst.{
  - Quality of the instruments (meter stick vs micro-meter)
  - Experience of the person doing measurements
  - Etc

- In many cases, uncertainties are more important and difficult to estimate than the central (or mean) values

Significant Figures – I

- Denote the precision of the measured values
  - The number 80 implies precision of +/- 1, between 79 and 81
    - If you are sure to +/-0.1, the number should be written 80.0
  - Significant figures: non-zero numbers or zeros that are not place-holders (Rapid poll 4)
    - 34, 34.2, 0.001, 34.100
      - 34 has two significant digits
      - 34.2 has 3
      - 0.001 has one because the 0's before 1 are place holders to position "."
      - 34.100 has 5, because the 0's after 1 indicates that the numbers in these digits are indeed 0's.
    - When there are many 0's, use scientific notation for simplicity:
      - $31400000=3.14\times10^{7}$
      - $0.00012=1.2\times10^{-4}$
    - How about 3000?
      - This book assumes all 0's are significant but it could be different in other cases!

Significant Figures – II

- Operational rules:
  - Addition or subtraction: Keep the **smallest number of decimal place** in the result, independent of the number of significant digits: 12.001+ 3.1= 15.1
  - Multiplication or Division: Keep the **smallest number of significant digits** in the result: 12.001 x 3.1 = 37, because the smallest significant figures is ?.

What does this mean? **The worst precision determines the precision the overall operation!!**

In English? **Can't get any better than the worst measurement!**