PHYS 1443 – Section 003
Lecture #1

Monday, Aug. 25, 2003
Dr. Jaehoon Yu

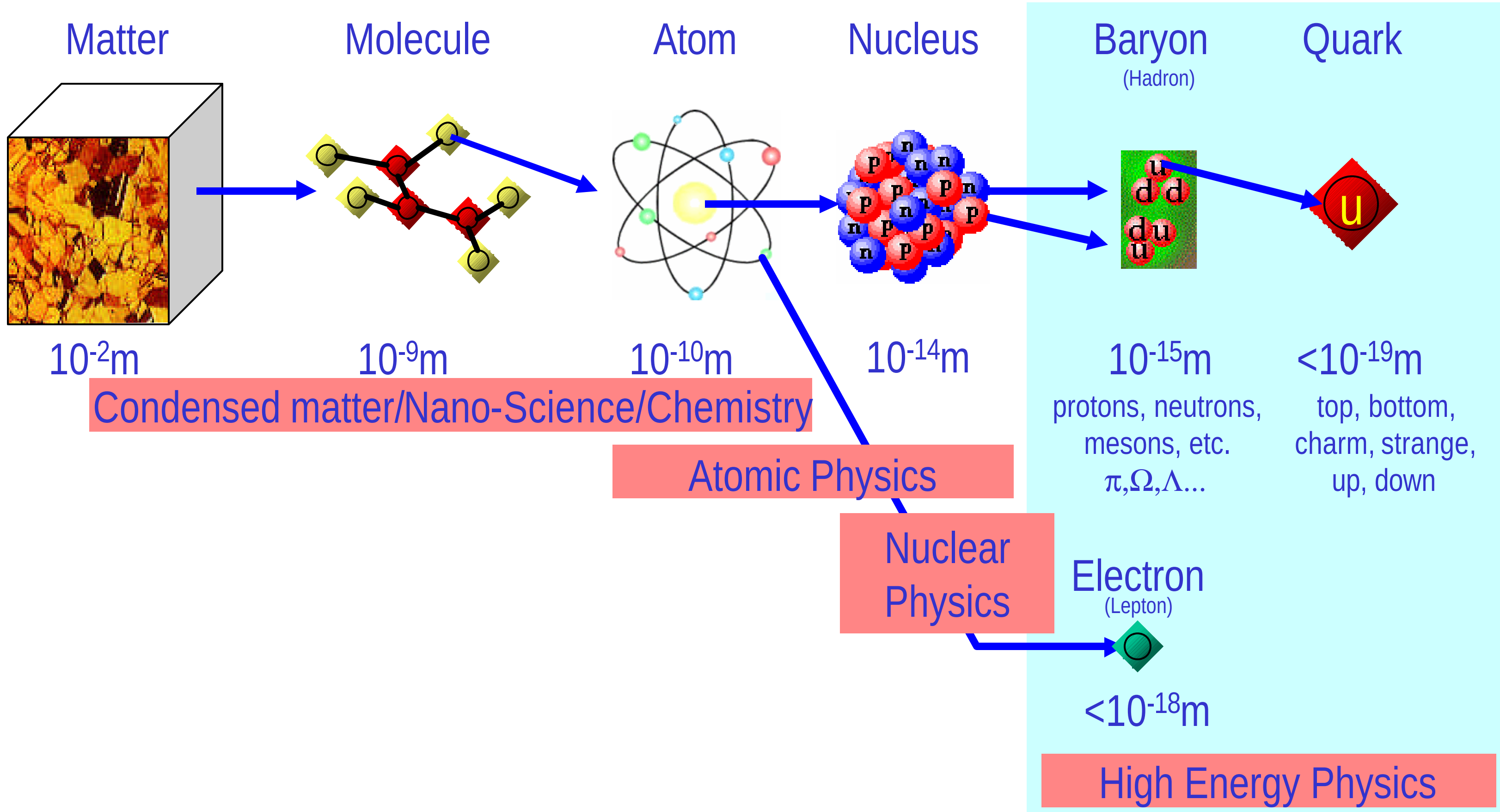
1. Who am I?
2. How is this class organized?
3. What is Physics?
4. What do we want from this class?
5. Brief history of physics
6. Chapter one
   - Uncertainties and Significant Figures
   - Standards and units
   - Estimates
   - Dimensional Analysis

Today's homework is homework #1, due 1pm, next Wednesday!!

Who am I?

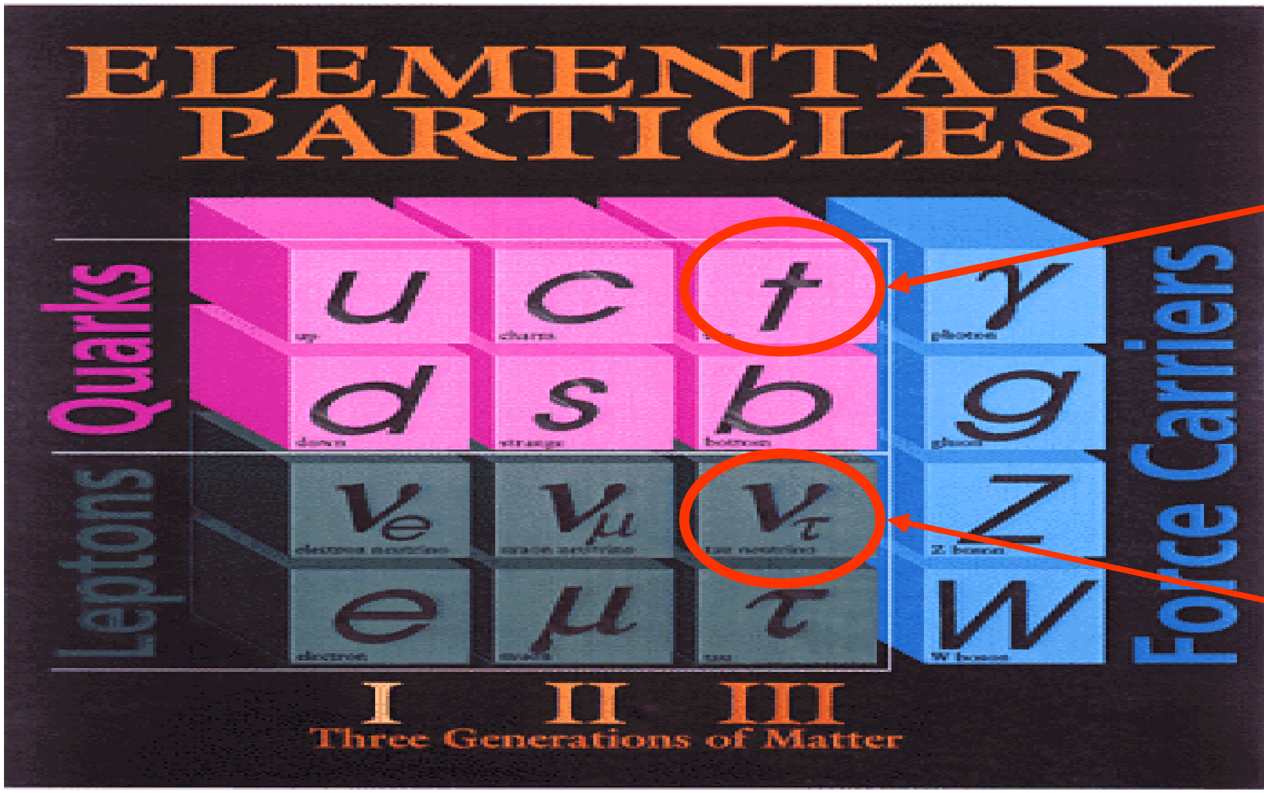
- Name: Dr. Jaehoon Yu (You can call me **Dr. Yu**)
- Office: Rm 242A, Science Hall
- Extension: x2814, E-mail: *jaehoonyu@uta.edu*
- My profession:High Energy Physics (HEP)
  - Collide particles (protons on anti-protons or electrons on anti-electrons, positrons) at the energies equivalent to 10,000 Trillion degrees
  - To understand
    - Fundamental constituents of matter
    - Interactions or forces between the constituents
    - Creation of Universe (**Big Bang** Theory)
  - A pure scientific research activity
    - Direct use of the fundamental laws we find may take longer than we want but
    - Indirect product of research contribute to every day lives; eg. WWW

Structure of Matter



The Standard Model

- Assumes the following fundamental structure:

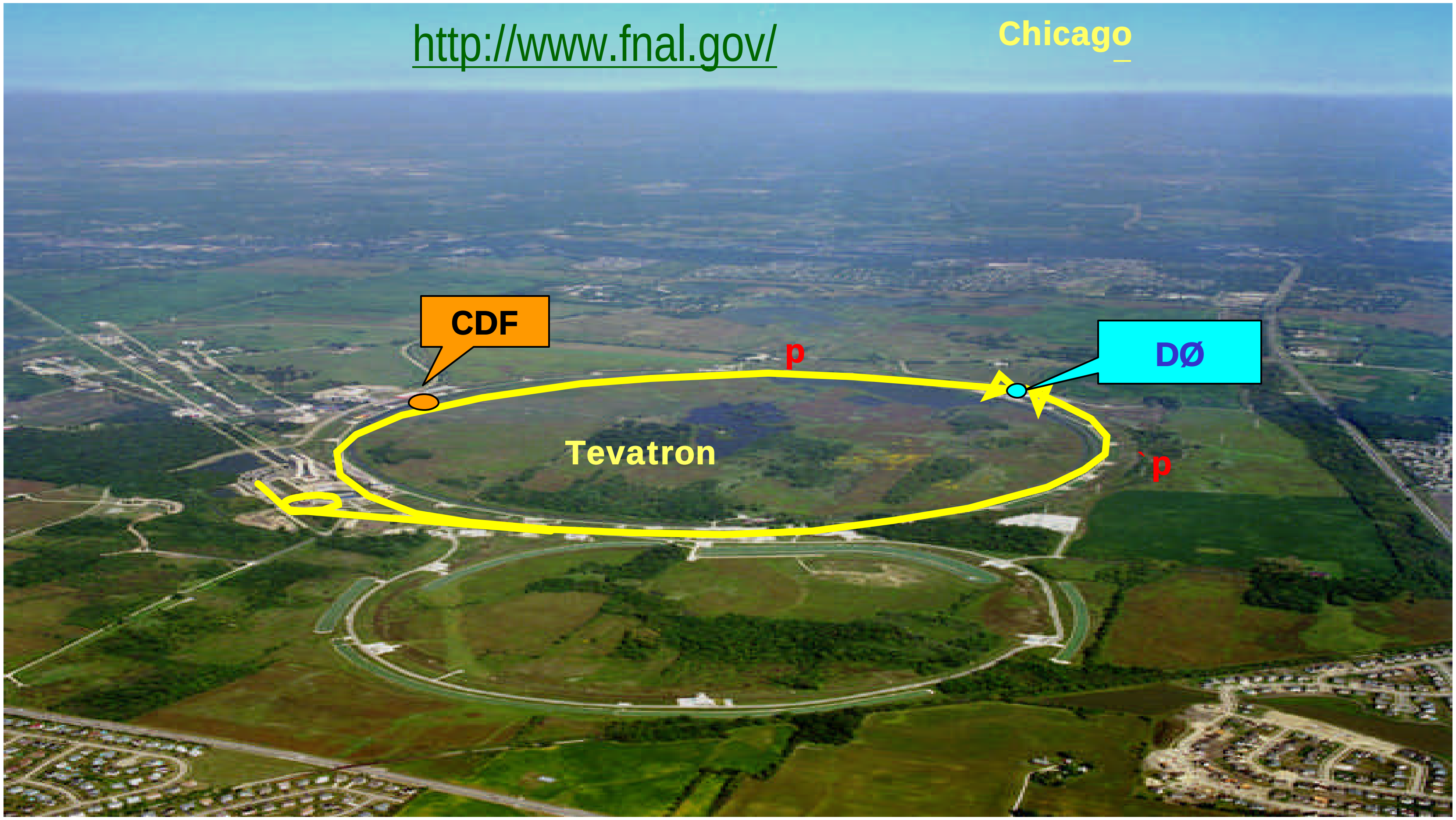


Discovered in 1995

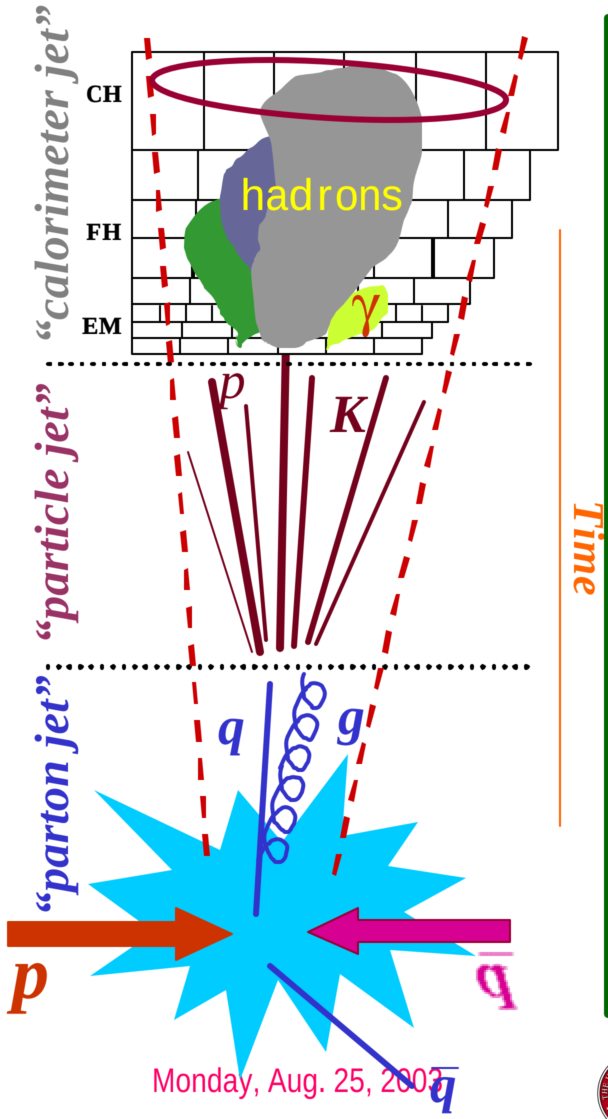
Directly observed in 2000

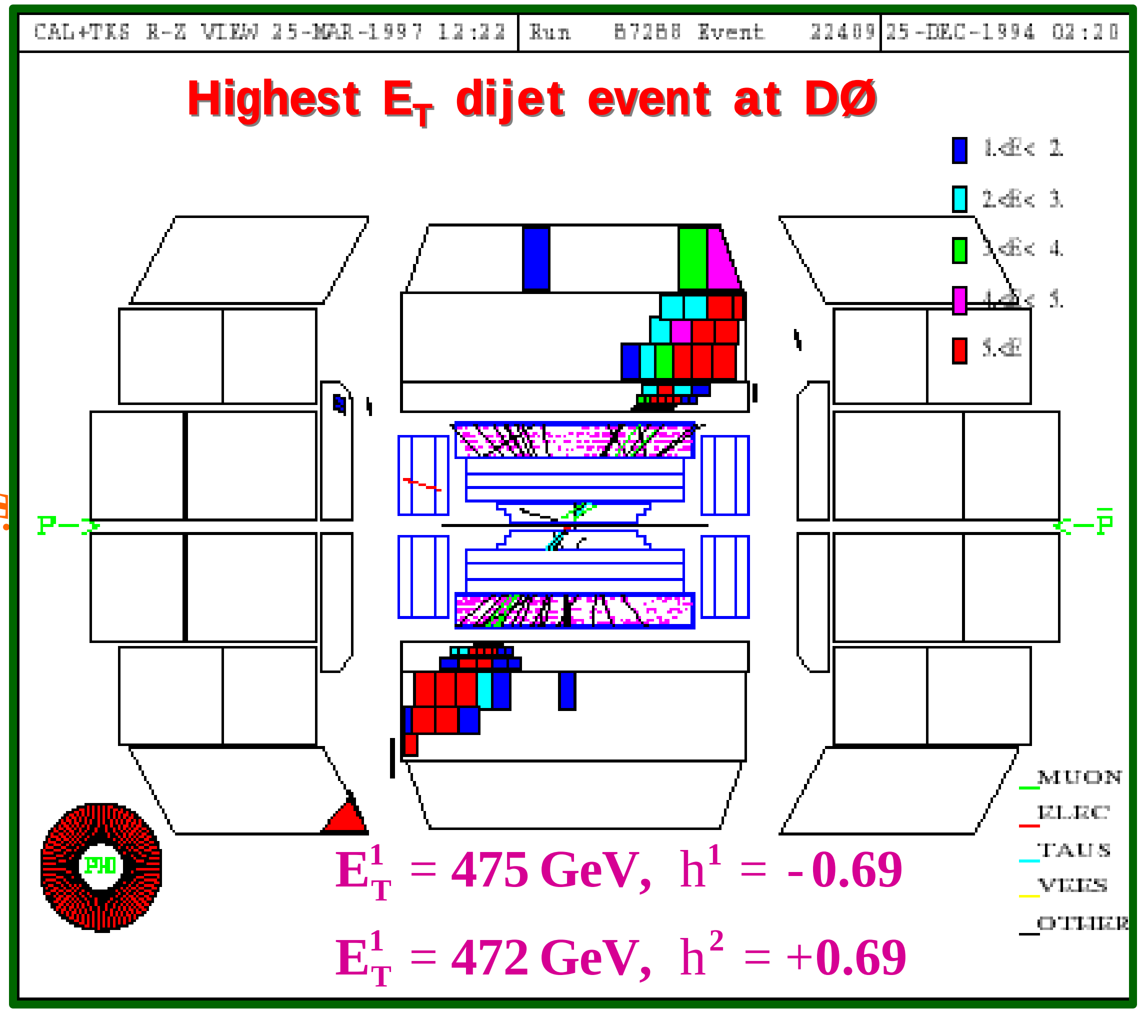
Fermilab Tevatron Accelerator

- World's Highest Energy proton-anti-proton collider
  - E_{cm}=1.96 TeV (=6.3x10^{-7}J/p➔ 1.3MJoule)



How does an Event Look in a Collider Detector?





Information & Communication Source

- My web page: http://www-hep.uta.edu/~yu/
  - Contact information & Class Schedule
  - Syllabus
  - Holidays and Exam days
  - Evaluation Policy
  - Class Style & homework
  - Other information
- Primary communication tool is e-mail: Register for PHYS1443-003-FALL03 e-mail distribution list as soon possible
- Office Hours: 2:30 – 3:30pm, Mondays and Wednesdays

Primary Web Page

Course Specification for 1443 - 003, Fall 2003 - Microsoft Internet Explorer

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Address http://www-hep.uta.edu/~yu/teaching/fall03-1443-003/fall03-1443-003.html Go Links

Course Specification for 1443-003, Fall 2003

Class Schedule	1:00 - 2:20pm Mondays & Wednesdays Room 103, Science Hall
Instructor	Dr. Jaehoon Yu
Office	Room 242A, Science Hall Phone: (817) 272 - 2814 Secretary: (817) 272 - 2811 Fermilab Office: (630) 840 - 8308
Office Hours	2:30pm - 3:30pm Mondays and Wednesdays
Prerequisites	MATH 1426 or concurrent enrollment. You must enroll in a relevant lab section, unless exempt
Textbook	Physics for Scientists and Engineers, 3rd Edition Douglas C. Giancoli Prentice Hall

- Syllabus
- Lecture Notes
- Home Work Assignments
- Link to Physics Labs
- Term Exam Problems and Solutions
- Class Style & Communication methods
- Holidays & Exam Days
- Evaluation Policy
- Contact Information
- Other Information

Internet

Syllabus for PHYS 1443 - 003, Fall 2003 - Microsoft Internet Explorer

http://www-hep.uta.edu/~yu/teaching/fall03-1443-003/syllabus.html

Syllabus for1443-003, Fall 2003

Period	Chapters
Weeks of Aug. 25 and Sept. 1, 2003	Chapters 1 - 3: Estmiate, measurements, One and two dimensional motion (No class on Labor day, Monday, Sept. 1, 2003)
Weeks of Sept. 8 and Sept. 15, 2003	Chapters 4 and 5: Newton's Law of Motion, Further application of Newton's Laws
Week of Sept. 22, 2003	Chapter 6: Gravitation and Newton's Synthesis
Monday, Sept. 29, 2003	**First Term Exam (Chap. 1 - 6)**
Oct. 1 & Weeks of Oct. 6 and Oct. 13, 2003	Chapters 7 - 9: Work and Energy, Energy Conservation, Linear Momentum and Collisions
Weeks of Oct. 20 and Oct. 27, 2003	Chapters 10 - 12: Rotational Motion about a fixed axis, General Rorational Motion, Static equilibrium
Monday, Nov. 3, 2003	**Second Term Exam (Chap 7 - 12)**
Nov. 5 & Weeks of Nov. 10 and Nov. 17, 2003	Chapters 13 - 16: Fluids, Oscillations, Wave Motion and sound
Weeks of Nov. 24 and Dec. 1, 2003	Chapters 17 - 20: Thermodynamics, Theory of Gases, Thermodynamic Laws
Monday, Dec. 8, 2003	**Third (Final) Term Exam (Chap. 13 - 20)**

Holidays and Exam Days for PHYS 1443 - 003, Fall 2003 - Microsoft Internet Explorer

http://www-hep.uta.edu/~yu/teaching/fall03-1443-003/exams-n-holidays.html

Holidays & Exam days for 1443-003, Fall 2003

Catrgory	Dates
Labor Day	Monday, Sept. 1, 2003
First Term Exam	Monday, Sept. 29, 2003
Second Term Exam	Monday, Nov. 3, 2003
Thanksgiving Holidays	Thursday, Nov. 27 - Saturday, Nov. 30, 2003
Final Exam	Monday, Dec. 8, 2003

Evaluation Policy

- Term Exams: 50%
  - Total of three term exams
  - Best two of the three will be chosen
  - Each will constitute 25% of the total
  - Missing an exam is not permissible unless pre-approved
    - No makeup test
- Lab score: 20%
- Homework: 15%
- Pop-quizzes: 15%
- Extra credits: 10% of the total
  - Random attendances
  - Strong participation in the class discussions
  - Other many opportunities
- Will be on sliding scale unless everyone does very well

Homeworks

- Solving chapter problems is the only way to comprehend class material
- An electronic homework system has been setup for you
  - Details are in the material distributed today
  - https://hw.utexas.edu/studentInstructions.html
  - Roster will close next Wednesday, Sept. 3
- Each homework carries the same weight
- Home work will constitute **15% of the total** ➔ A good way of keeping your grades high

Attendances and Class Style

- Attendances:
  - Will be taken randomly
  - Will be used for extra credit
- Class style:
  - Lectures will be on electronic media
    - The lecture notes will be posted **AFTER** each class
  - Will be mixed with traditional methods
  - Active participation through questions and discussions are **STRONGLY** encouraged → Extra credit….

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

? Improves our everyday lives, though some laws can take a while till we see amongst us

What do we want from this class?

- Physics is everywhere around you.
- Understand the fundamental principles that surrounds you in everyday lives…
- Identify what law of physics applies to what phenomena…
- Understand the impact of such physical laws
- Learn how to research and analyze what you observe.
- Learn how to express observations and measurements in mathematical language.
- Learn how to express your research in systematic manner in writing
- I don't want you to be scared of PHYSICS!!!

Brief History of Physics

- AD 18^{th} century:
  - Newton's Classical Mechanics: A theory of mechanics based on observations and measurements
- AD 19^{th} Century:
  - Electricity, Magnetism, and Thermodynamics
- Late AD 19^{th} and early 20^{th} 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?

Uncertainties

- Physical measurements have limited precision, however good it is, due to:
  - Stat.{ – Number of measurements
  - Syst.{ – Quality of 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

- Significant figures denote the precision of the measured values
  - Significant figures: non-zero numbers or zeros that are not place-holders
    - 34 has two significant digits, 34.2 has 3, 0.001 has one because the 0's before 1 are place holders, 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:
      - $31400000=3.14\times10^{7}$
      - $0.00012=1.2\times10^{-4}$

Significant Figures

- Operational rules:
  - Addition or subtraction: Keep the **smallest number of decimal place** in the result, independent of the number of significant digits: 34.001+120.1=154.1
  - Multiplication or Division: Keep the **smallest significant figures** in the result: 34.001x120.1 = 4083, because the smallest significant figures is 4.

Needs for Standards and Units

- Basic quantities for physical measurements
  - Length, Mass, and Time
- Need a language that everyone can understand each other
  - Consistency is crucial for physical measurements
  - The same quantity measured by one must be comprehendible and reproducible by others
  - Practical matters contribute
- A system of unit called **SI** (*System International*) established in 1960
  - Length in meters (*m*)
  - Mass in kilo-grams (*kg*)
  - Time in seconds (*s*)

Definition of Base Units

SI Units	Definitions
1 *m (Length)* = *100 cm*	One meter is the length of the path traveled by light in vacuum during a 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 prefixes that scales the units larger or smaller for convenience (see pg. 7)*
- *Units for other quantities, such as Kelvins for temperature, for easiness 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/

Examples 1.3 & 1.4

- Ex 1.3: A silicon chip has an area of 1.25in^2. Express this in cm^2.

$$1.25\,\text{in}^2 = 1.25\,\text{in}^2 \times \left(\frac{2.54\,\text{cm}}{1\,\text{in}}\right)^2$$

$$= 1.25\,\text{in}^2 \times \left(\frac{6.45\,\text{cm}^2}{1\,\text{in}^2}\right)$$

$$= 1.25 \times 6.45\,\text{cm}^2 = 8.06\,\text{cm}^2$$

- Ex 1.4: Where the posted speed limit is 65 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)?

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

(a) $$65\,\text{mi/h} = (65\,\text{mi})\left(\frac{1609\,\text{m}}{1\,\text{mi}}\right)\left(\frac{1}{1\,\text{h}}\right)\left(\frac{1\,\text{h}}{3600\,\text{s}}\right) = 29.1\,\text{m/s}$$

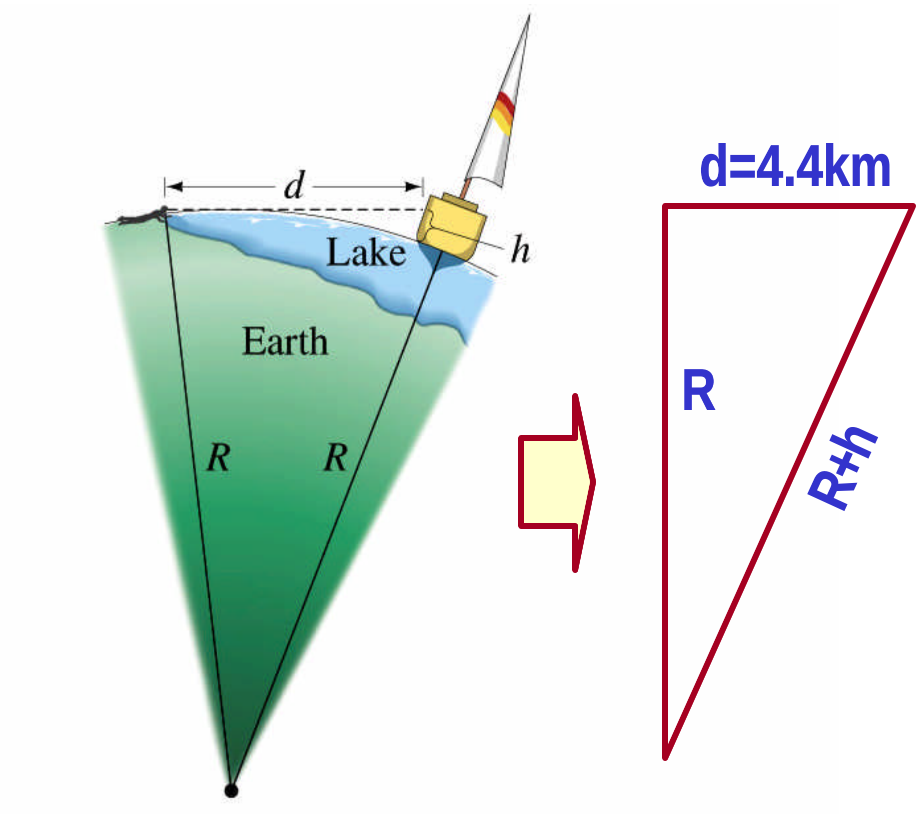
(b) $$65\,\text{mi/h} = (65\,\text{mi})\left(\frac{1.609\,\text{km}}{1\,\text{mi}}\right)\left(\frac{1}{1\,\text{h}}\right) = 104\,\text{km/h}$$

Estimates & Order-of-Magnitude Calculations

- Estimate = Approximation
  - Useful for rough calculations to determine the necessity of higher precision
  - Usually done under certain assumptions
  - Might require modification of assumptions, if higher precision is necessary
- Order of magnitude estimate: Estimates done to the precision of 10s or exponents of 10s;
  - Three orders of magnitude: 10^3=1,000
  - Round up for Order of magnitude estimate; $8 \times 10^7 \sim 10^8$
  - Similar terms: "Ball-park-figures", "guesstimates", etc

Examples 1.8

Estimate radius of the Earth using triangulation as shown in the picture when d=4.4km and h=1.5m.



Pythagorian theorem

$$(R+h)^2 \approx d^2 + R^2$$

$$R^2 + 2hR + h^2 \approx d^2 + R^2$$

Solving for R

$$R \approx \frac{d^2 - h^2}{2h}$$

$$= \frac{(4400m)^2 - (1.5m)^2}{2 \times 1.5m}$$

$$= 6500km$$

Dimension and Dimensional Analysis

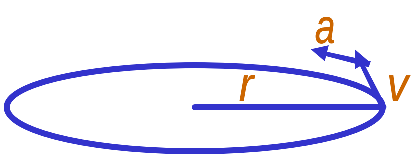
- An extremely useful concept in solving physical problems
- Good to write physical laws in mathematical expressions
- No matter what units are used the base quantities are the same
  - *Length* (distance) is length whether meter or inch is used to express the size: Usually denoted as *[L]*
  - The same is true for *Mass ([M])*and *Time ([T])*
  - One can say "Dimension of Length, Mass or Time"
  - Dimensions are used as algebraic quantities: Can perform algebraic operations, addition, subtraction, multiplication or division

Dimension and Dimensional Analysis

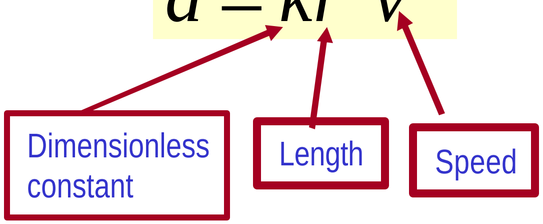
- One can use dimensions only to check the validity of one's expression: Dimensional analysis
  - Eg: Speed $[v] = [L]/[T]=[L][T^{-1}]$
    - *Distance (L) traveled by a car running at the speed V in time T*
    - $L = V*T = [L/T]*[T]=[L]$
- More general expression of dimensional analysis is using exponents: eg. $[v]=[L^nT^m] =[L]\{T^{-1}]$ *where* $n = 1$ *and* $m = -1$

Examples

- Show that the expression *[v] = [at]* is dimensionally correct
  - Speed: *[v]* =L/T
  - Acceleration: *[a]* =L/T^2
  - Thus, *[at]* = (L/T^2)xT=LT$^{(-2+1)}$ =LT^{-1} =L/T= *[v]*
- Suppose the acceleration *a* of a circularly moving particle with speed *v* and radius *r* is proportional to r^n and v^m. What are *n* and *m*?



$$a = kr^n v^m$$



$$L^1T^{-2} = (L)^n\left(\frac{L}{T}\right)^m = L^{n+m}T^{-m}$$

$$-m = -2 \Rightarrow m = 2$$

$$n + m = n + 2 = 1 \Rightarrow n = -1$$

$$a = kr^{-1}v^2 = \frac{v^2}{r}$$