Discussion - 2

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Please send me feedback at:

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About discussions

- Format:
  - 15 30 minutes of presentation depending on content – recap of whatever we’ve done in class. Stress on problem solving.
  - Lots of time for Questions and Answers
  - A couple of problems similar to the homework worked out

- NOTE: The presentation part will be very similar in both discussions of every week.
Getting Help

- Discussion sessions
- Office Hours
- Coaching sessions at RLM 5th Level
- E-Mail me: asimha@physics.utexas.edu
Outline

1. Summarizing Lecture 1
   - Historical Perspective
   - What is Science?

2. Summarizing Lecture 2
   - Units and Dimensions
   - Significant Figures
   - Orders of magnitude and Estimation
   - Scaling
   - Math stuff!
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Historical development of Physics

- Ancient Greeks: Euclid, Pythagoras, Archimedes
- No insistence on experimental backing till Galileo
- Copernicus – Heliocentric Model
- Tycho Brahe’s observations
- Kepler’s Laws
- Galileo’s observation of Jupiter’s Moons
- Newton’s Laws of Motion
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Scientific Method

Unexplored Observation

Hypothesis

Experiment to test the Hypothesis

Experiments agree!

Confirm with more Experiments

Theory!

Frame another Hypothesis

NOTE: A theory is a very well tested, reliable idea
Validity of Theories

- Theories are provisional
- Theories of physics we know are only approximate descriptions of reality
In PHY302K, we’ll be studying Classical Mechanics.

Classical Mechanics is only valid at low speeds (compared to light), weak gravity, and for large objects – essentially, everyday life.
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Dimensions

- Basic Measurements: Mass, Length, Time
- Denote by square brackets: eg: [speed of light] = \( LT^{-1} \)
- Dimensions cancel while multiplying / dividing!
- Addition: One can only add objects of the same dimension. It’s makes no sense to add mass and length.
Units

- **SI base units:** kg, m, s...
- **Derived units:** $m\, s^{-1}$ (velocity)
- **Other systems:** pound, foot, second

*NOTE:* “Dimensions” refer to the quantities that we measure. We measure them as multiples of units.
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Maintaining Significant Figures

- Maintaining the uncertainty of a measurement
- Zeros after a decimal point count (unless there are no non-zero numbers preceding the decimal point)
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Orders of magnitude

- Physics deals with a large range of length, time and mass scales!
- Denoting quantities in scientific notation is inevitable
- NOTE: Calculators show $5.3 \times 10^6$ as $5.3E6$
- Make sure you’re comfortable manipulating powers. If not, get help.
- Orders of magnitude estimates – round to the nearest power of 10. Don’t care about petty numbers like $\frac{1}{2}$, $\pi$ etc.
Orders of magnitude

Nature covers a large range of lengths, masses and time scales.

- **Mass:** $10^{-31} \text{ kg}$ to $10^{52} \text{ kg}$
- **Length:** $10^{-35} \text{ m}$ to $10^{25} \text{ m}$
- **Time:** $10^{-42} \text{ s}$ to $10^{17} \text{ s}$
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Scaling!

- Very important in physics!
- Many a time, we aren’t interested in constants of proportionality. Just in the nature of dependence of one quantity on another. That’s when scaling rocks!
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Why math?

• Intuition? That doesn’t work!
• Gives you predictive superpowers!
• It’s like magic – it works!
Math required here

Do any of you need help with any of these?

- Coordinate Systems
- Trigonometry
- Vectors
- Straight Lines
- Parabolas
- Calculus
“You don’t know anything until you’ve practiced!” – Richard P Feynman

Visualize what’s happening – it helps a lot!

Ref. 1.9 in the textbook.
Some data

- 1 mi = 1.609 km
- 1 au (Astronomical Unit): The mean distance between the earth and the sun = $1.5 \times 10^{11} \, m$

Dimensions of fundamental constants:
- Speed of Light: $[c] = LT^{-1}$
- Gravitational Constant: $[G] = M^{-1}L^3T^{-2}$
- Planck’s Constant (Not encountered in this course): $[h] = ML^2S^{-1}$.

Dimensions of some quantities:
- Force: $MLT^{-2}$
- Energy: Force $\times$ Distance, i.e. $ML^2T^{-2}$
- Momentum: $MLT^{-1}$
- Frequency: $T^{-1}$