DEVIL PHYSICS

THE BADDEST CLASS ON CAMPUS

AP PHYSICS

LSN 1-1, THE NATURE OF SCIENCE
LSN 1-2, PHYSICS AND ITS RELATION TO OTHER FIELDS
LSN 1-3, MODELS, THEORIES AND LAWS
LSN 1-4, MEASUREMENT AND UNCERTAINTY; SIGNIFICANT FIGURES

The Big Picture: Theory of Everything

Reading Activity Questions?

- Reading Activity 1-1 to 1-4

AP Learning Objective(s):

- Content Connection: This essential knowledge does not produce a specific learning objective but serves as a foundation for other learning objectives in the course.

Objectives

- Appreciate what physics is.
- Be able to calculate uncertainty for a measuring tool and estimate uncertainty in a measurement process.
- Be able to calculate percent uncertainty for a given measurement.

Objectives

- Know the meaning and importance of significant figures and be able to give the answer to a problem in the correct number of significant figures.
- SC.912.N.3.1: Explain that a scientific theory is the culmination of many scientific investigations drawing together all the current evidence concerning a substantial range of phenomena thus, a scientific theory represents the most powerful explanation scientists have to offer. (High)

Objectives

- SC.912.N.3.3: Explain that scientific laws are descriptions of specific relationships under given conditions in nature, but do not offer explanations for those relationships. (Moderate)
- SC.912.N.3.4: Recognize that theories do not become laws, nor do laws become theories; theories are well supported explanations and laws are well supported descriptions.(Moderate)
- SC.912.N.3.5: Describe the function of models in science, and identify the wide range of models used in science. (Moderate)

What is Physics?

- Physics is the attempt to explain everything that occurs in nature
- Physics attempts to put all of life in mathematical terms in order to predict events through cause and effect
- Physics is the basis of all other sciences

Classical Physics:

- Motion
- Fluids
- Heat
- Sound
- Light
- Electricity
- Magnetism

Modern Physics

- Relativity
- Atomic Structure
- Nuclear Physics
- Elementary Particles
- Astrophysics

SCIENCE AND CREATIVITY

- Science: The creative search for order in what we observe around us.
  - The search for relationships and the implications of those relationships
  - To ultimately determine cause-and-effect relationships

SCIENCE AND CREATIVITY

- Science: The creative search for order in what we observe around us.
  - Observe
  - Question
  - Inquire
  - Experiment
  - Verify
  - Ask, "Okay, what now?" or "What if?"

SCIENCE AND CREATIVITY

- Observation: Creative way of looking at things.

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SCIENCE AND CREATIVITY

- Observation: Creative way of looking at things.
  - The glass is half full
  - The glass is half empty

SCIENCE AND CREATIVITY

- Observation: Creative way of looking at things.
  - The glass contains a fluid that is mostly incompressible, exerts pressure equally upon all surfaces of a submerged object, exhibits surface tension, and can be used to measure the volume of an object by measuring the amount of displaced water when the object is submerged in it. Furthermore, if the density of the object is less than that of water it will float whereas if it is greater it will sink.

SCIENCE AND CREATIVITY

- Hypothesis: Preliminary explanation of an observation
  - Your best guess of why something happens based on prior knowledge
  - It is okay if a hypothesis turns out to be wrong
    - Thomas Edison and the light bulb
  - Experimentation, testing, measurement
  - Replication

SCIENCE AND CREATIVITY

- Theory: Used to explain and give order to the observation
  - Product of the scientific process
  - Must stand up to testing
  - Can't be proved absolutely, because measuring instruments can't be absolutely precise and/or you can't know everything

SCIENCE AND CREATIVITY

- Theory: (cont)
  - Frequently replaced by 'improved' theories
    - Yields quantitatively closer values to experimentation
    - Explains a larger range of phenomena
    - Unifies several theories
  - Quantitatively predicts phenomena

PHYSICS AND ITS RELATION TO OTHER FIELDS

- All science collectively known as natural philosophy
- Leonardo da Vinci – artist, researcher, engineer – harmony of the arts and sciences
  - Body measurement experiment
- Physics interacts with everything around us.

MODELS, THEORIES AND LAWS

- Models: Karlee O'Donnell is one of my favorites, but that's not important or testable
- Scientific Model: An analogy or mental / physical image of a phenomenon in terms we are familiar with.

MODELS, THEORIES AND LAWS

- Scientific Model: An analogy or mental / physical image of a phenomenon in terms we are familiar with.
  - A ripple tank filled with water serves as a model for the wave nature of light.
  - Can suggest new ideas or experiments about other related phenomena leading to new theories

MODELS, THEORIES AND LAWS

- Scientific Theory:
  - Broader and more detailed than a model
  - Provides quantifiably testable predictions
  - Attempts to explain why things happen the way they do
  - Examples:
    - Wave Theory of Light
    - Theory of Evolution
    - Big Bang Theory

MODELS, THEORIES AND LAWS

- Scientific law: Concise but general statements about how nature behaves.
  - Often takes the form of a relationship or equation (an equation is a relationship)
  - Must be experimentally valid over a wide range of observed phenomena

MODELS, THEORIES AND LAWS

- Scientific law: (cont)
  - Governmental laws are *prescriptive* – tell you how we ought to behave, which we may or may not do
  - Scientific laws are *descriptive* – tells how things do behave based on observations, experiments and measurements

MODELS, THEORIES AND LAWS

- Scientific law: (cont)
  - We work as if the laws and principles are true, with an open mind that there may be another explanation
    - Nearly 70 years of aeronautical engineering were based on Bernoulli's equation backed up by wind tunnel data
    - The data did not always line up with what was predicted by Bernoulli
    - Research in the 90's showed that Bernoulli's equation was over-simplified and did not take into account several other factors http://www.grc.nasa.gov/WWW/K-12/airplane/bernnew.html

MODELS, THEORIES AND LAWS

- Principle:
  - Not Mr. Bennett, he's a princi<u>pal</u>
  - Less general than a law which normally encompasses many different observations
  - The line between laws and principles is somewhat arbitrary and not always consistent
    - Ideal Gas Law only applies to ideal gasses and then only below the critical temperature when the pressure is not too great.
    - But Archimedes Principle works all the time

MATH – A TOOL OF PHYSICS

Physics – Real or Ideal

MEASUREMENT AND UNCERTAINTY

CHEM 1210
General Chemistry I

Units and Uncertainty

Prof. Chuck Wight

THE UNIVERSITY OF UTAH

MEASUREMENT AND UNCERTAINTY

- Uncertainty:
  - No measurement is absolutely precise, so there is always a degree of uncertainty

MEASUREMENT AND UNCERTAINTY

- Estimated Uncertainty:
  - Uncertainty experiment: Measure the length of your table in millimeters
    - What possible errors can occur when measuring?
    - Is there a better tool?

MEASUREMENT AND UNCERTAINTY

- Estimated Uncertainty:
  - By convention, when using a tool the estimated error is half of the smallest unit of measure on an instrument.
  - If you are measuring with a classroom ruler, the smallest increment on the ruler is 1 mm. The uncertainty would then be ±0.5 mm. A measurement could be 64 ±0.5 mm or 6.4 ±0.05 cm

MEASUREMENT AND UNCERTAINTY

- Uncertainty:
  - There may also be human error in making measurements. For instance, if the item you are measuring is longer than the ruler, you will have to use your best judgment in deciding how much human error is introduced in moving and re-aligning the ruler.

MEASUREMENT AND UNCERTAINTY

- Uncertainty:
  - For electronic devices, or when there is no other guidance, use ±1 of the least significant digit:
    - 123 gives uncertainty of ±1
    - 1.23 gives uncertainty of ±0.01
    - about 1230 gives uncertainty of ±10

MEASUREMENT AND UNCERTAINTY

- Uncertainty:
  - If you have no other information about a number, the uncertainty is ±1 of the least significant digit – same as digital devices:
    - 123 gives uncertainty of ±1
    - 1.23 gives uncertainty of ±0.01
    - about 1230 gives uncertainty of ±10

MEASUREMENT AND UNCERTAINTY

- Percent Uncertainty
  - Ratio of the uncertainty to the measurement expressed as a percent (x 100%)
  - For example, 64 ±0.5 mm could be expressed as 64 ±[(.5/64) x 100% = 0.78%] mm or 6.4 ±0.78% cm

Significant Figures

- Karlee O'Donnell has a significant figure, but that's not important or testable
- The number of reliably known digits in a number

Significant Figures

- Determining number of significant figures:
  - 6.4 has two significant digits
  - 0.0064 has two significant digits (the zeroes are just placeholders)
  - 6.004 has 4 significant digits (the zeroes are part of the number)
  - 64.00 has 4 significant digits (in this situation, if the zeroes are given when they aren't needed, it is assumed that they are significant)

Significant Figures

- Determining number of significant figures:
  - 6,400 has [it depends] significant digits
    - This can go either way.
    - If the text says "about 6400" then the zeroes aren't significant, there are only two significant digits and it should be written as 6.4×10^3
    - If the text says "exactly 6400" then the zeroes are significant, so four significant figures
    - If it doesn't say either, two significant figures

Significant Figures

- Determining number of significant figures:
  - Defined values, such as conversion factors, do not place a limit on significant figures.
    - If you use 1m/100cm or 60s/1min, these conversions do not establish a number of significant figures.
    - But, 1kg ≅ 2.2 lbs does! The 2.2 lbs is approximate so you now have a number with 2 significant digits

Significant Figures

- Determining number of significant figures:
  - Do not confuse values from a table with defined values.
  - Values from a table are considered significant figures.

Significant Figures

- The solution to a multiplication or division problem should not contain more significant digits than the input with the least significant digits.
  - The reason for this is your answer cannot be more precise than your inputs.
  - If you measure a rug to be 6.3m x 2.8m, the area equals 6.3m x 2.8m = 17.64 m^2 . Since the inputs contain only two significant digits, your answer will be 18 m^2

Significant Figures

- The solution to a multiplication or division problem should not contain more significant digits than the input with the least significant digits.
  - It is okay, and even preferred, to carry insignificant digits until your final answer, especially on your calculator
    - if you carry the insignificant digits in your calculator
    - if you don't
  - I normally look for ±5% from my computed answer to be a correct answer due to different ways to use a calculator

Significant Figures

- When your answer is larger than the number of significant digits, you must use exponential or scientific notation
  - 63 x 25 = 1575, but the correct answer should be "about 1600" using significant figures, or the best answer is 1.6×10^3

Significant Figures

- I do not want to see an 8-digit number when the correct answer should have three significant digits in exponential notation
  - $3.2X10^{5} \div 1.7X10^{-2} \neq 18823529.41$
  - $3.2X10^{5} \div 1.7X10^{-2} = 1.9\ X10^{7}$

Summary: Can you

- Appreciate what physics is.
- Calculate uncertainty for a measuring tool and estimate uncertainty in a measurement process.
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Summary: Can you

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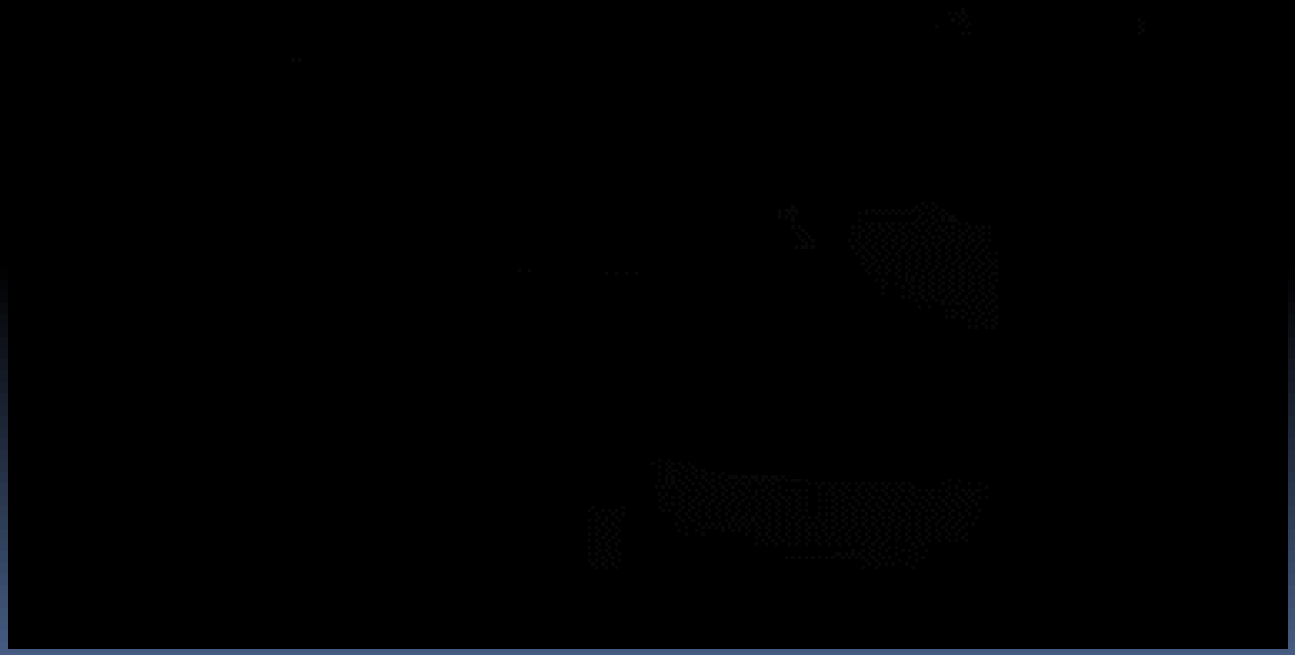
QUESTIONS?

Homework

Problems #1-9

Studying Physics

Physics at Keele College, UK



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