PHY135: College Physics I

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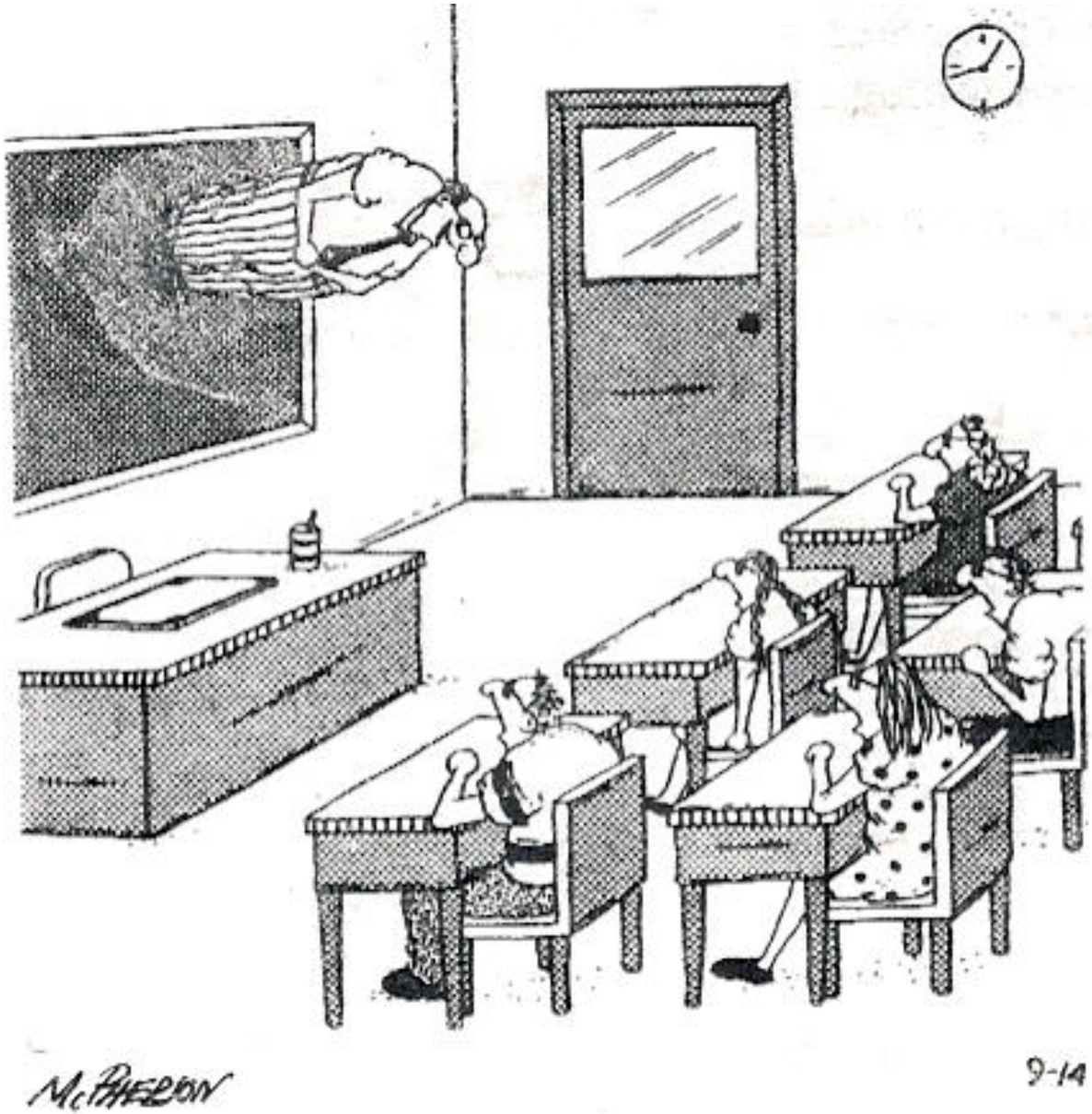
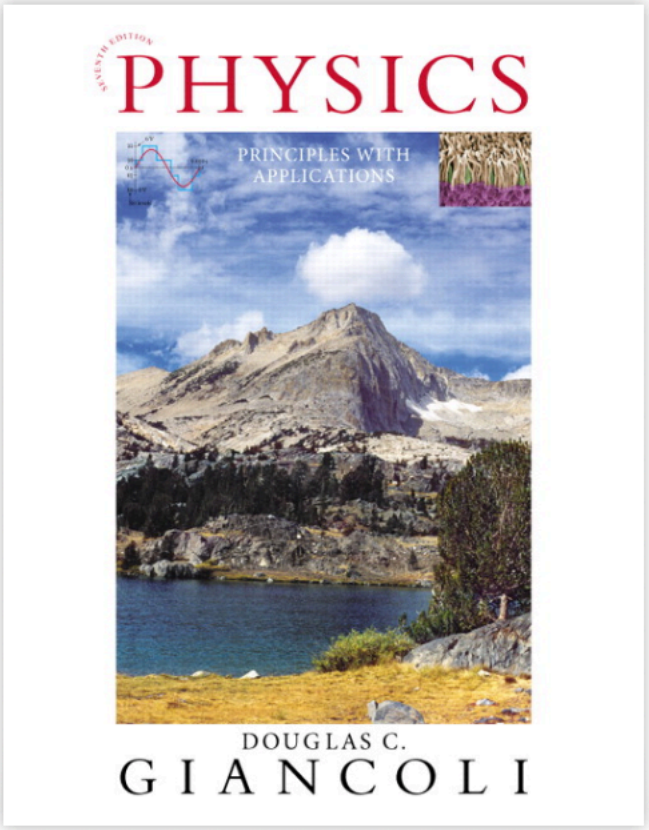


"Good morning, and welcome to
The Wonders of Physics."

An integrated theory/laboratory general college physics course without calculus. Topics will include fundamental concepts of units, vectors, equilibrium, velocity and acceleration in linear and rotational motion, force, energy, momentum, fluids at rest and in motion, and oscillatory motion.



Grade Distribution:

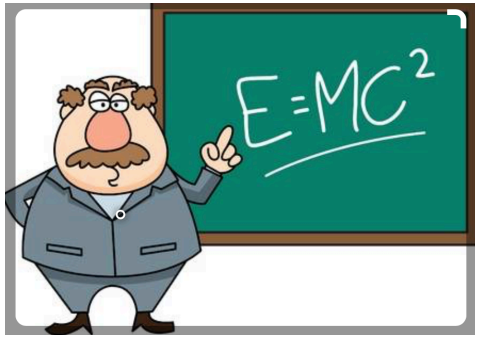
- Theory (75%)
  - Homework (15%)
  - 3 in class exams (3x15%=45%)
  - Final exam (40%)
- Lab (25%)

Important Announcement:

- **First in-class exam: 12Th September Thursdays (9:25-10.40)**
- **Chapters 1, 2, 3**

Math Pre-Requisites

- Math is the ***Language of Physics!!*** But, this is ***NOT*** a math course!! I'll not have time to teach math to you! I must assume that ***you know it!!*** The primary difficulties with the course are often math-related!!



Pre-Requisites:

  - **Math 129**
  - Or equivalent courses somewhere else!

- Take advantage of the:

Math Review in Appendix A!

Where to Go for Help??

From your Instructor!!!

Unfortunately there is no office hour for this course. But I will be available about an hour after the class. You can also email me with your question.

Your Fellow Students!!!

An effective strategy is to work on homework & to study for exams together in a group.

This is how professionals work in the "real world".

The Internet!!!

There are ***HUGE*** numbers of Physics Help Web sites!

Using google.com & typing in "Physics Help" gives about 381,000,000 hits!!!! I encourage you to try out some.

Bottom Line on Help

IF YOU NEED HELP, TAKE ADVANTAGE OF THE MANY HELP RESOURCES AVAILABLE!!

- If you need help & don't use these resources, only **YOU** are to blame!

To Succeed in this Course

- ***READ*** the book, which cost you many $$$!
  - It's most effective to read the material ***BEFORE*** I lecture over it.
- ***WORK*** the assigned homework problems!!
  - Before looking at the solutions. Copying the solutions will **NOT** teach you physics.
- ***WORK extra*** problems!
- ***COME TO CLASS!!***
  - There is a correlation between attendance & grade! Also, skipping means that you are **WASTING** the tuition & fees that you (or soemone) paid! With tuition & fees for a full-time student, each class meeting costs some $$$$. Each time you skip, you are throwing away many $$$$!! After a while this adds up! My lectures may not be entertaining or brilliant, but I do expose you to the material.

CHAPTER

1

Introduction, Measurement, Estimating

Physics

The most basic of *all sciences!*

- **Physics:**

  The "Parent" of all sciences!

- **Physics** =

  The study of the behavior and the structure of matter and energy and the interaction between them.

- **Goal of Physics** (& all of science):

  To quantitatively and qualitatively

  describe the "world around us".

Physics & its Relation to Other Fields

- The "Parent" of all Sciences!
- The foundation for and is connected to ***ALL*** branches of ***science and engineering***.
- Useful in everyday life & in ***MANY*** professions:
  - Chemistry, Life Sciences (Medicine, tec.), Architecture, Engineering, …

FIGURE 1–4 (a) This bridge over the River Tiber in Rome was built 2000 years ago and still stands. (b) The 2007 collapse of a Mississippi River highway bridge built only 40 years before.

(b)

Physics Principles are used in many practical applications, including construction. As the photo on the right clearly shows, communication of physics principles between ***Architects & Engineers*** ***is sometimes essential*** if disaster is to be avoided!!

FIGURE 1–4 (a) This bridge over the River Tiber in Rome was built 2000 years ago and still stands. (b) The 2007 collapse of a Mississippi River highway bridge built only 40 years before.

(b)

The Nature of Science

- Physics is an ***EXPERIMENTAL*** science!

Experiments & Observations:

Are important first steps toward a scientific theory.

Theories

  - A ***Quantitative (Mathematical) Description*** of experimental observations.
  - Are created to ***explain*** **experiments & observations**. Can also make **predictions**

Experiments & Observations:

Can tell if predictions are accurate.

- But, no theory can be absolutely 100% verified!
  - A theory can be proven false.

Model, Theory, Law

- **Model:** An analogy of a physical phenomenon to something we are familiar with.
- **Theory:** More detailed than a model. Puts the model into mathematical language

Law

- A concise & **general** statement about **how nature behaves**. Must be verified by many, many experiments! Only a few laws.
  - Do not confuse with the laws of government!

How does a **new theory** **get accepted**?

- **It's Predictions:**
  Agree better with data than those of an old theory
- **It Explains:**
  A greater range of phenomena than old theory

Example

- **Aristotle:**
  Believed that objects would return to rest once put in motion.
- **Galileo:**
  Realized that an object put in motion would stay in motion until some force stopped it.
- **Newton:**
  Developed his ***Laws of Motion*** to put Galileo's observations into mathematical language.

1-4 Measurement and Uncertainty; Significant Figures

No measurement is absolutely precise.

There is always some ***uncertainty*** due to limited instrument accuracy and difficulty on reading results.

The photograph to the left illustrates this – it would be difficult to measure the width of this **2×4** to better than a **millimeter**.

Measurement & Uncertainty

- Physics is an ***EXPERIMENTAL*** science!

  Experiments are ***NEVER*** **100%** accurate.

  - ***They ALWAYS*** **have** ***UNCERTAINTY*** in the final result.

  ≡ ***Experimental Error.***

  - It is common to state this precision (when known).

- Consider a simple measurement of the width of a board. Suppose the result is **23.2 cm**.
- However, suppose we know that our measurement is only accurate to an estimated **0.1 cm**.

  $\Rightarrow$ The width is written as **(23.2 ± 0.1) cm**

  ± 0.1 cm ≡ *Experimental Uncertainty*
- ***The Percent Uncertainty* is then:**

$$\pm (0.1/23.2) \times 100 \approx \pm 0.4\%$$

Significant Figures

("sig figs")

≡ ***The number of significant figures is the number of reliably known digits in a number.***

- It is usually possible to tell **The Number of Significant Figures** by the way the number is written:

23.21 cm has **4 significant figures**

0.062 cm has **2 significant figures**

(initial zeroes don't count)

80 km is **ambiguous:**

It could have **1 or 2 significant figures**. (0 is merely a place holder). If it has **3**, **it should be written 80.0 km**.

Calculations Involving Several Numbers

- It is usually possible to tell **The Number of Significant Figures** by the way the number is written:

When Multiplying or Dividing Numbers:

The number of significant digits in the result ≡

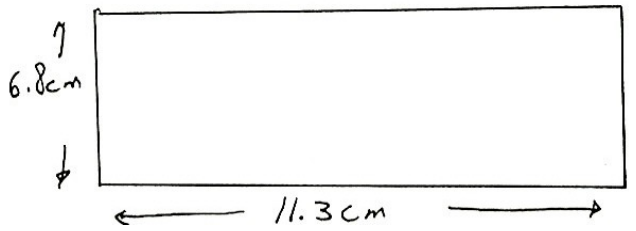
The same as the number used in the calculation which have the fewest significant digits.

When Adding or Subtracting Numbers:

The answer should contain no more decimal places than the number with the fewest decimal places.

Example

(Not to scale!)

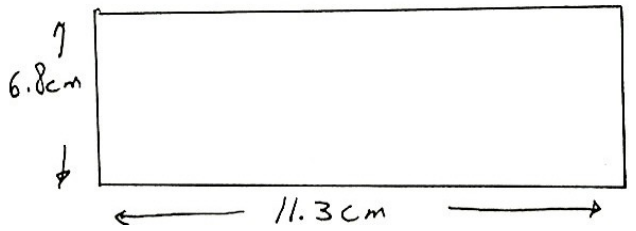


- Calculate the area **A** of a board with dimensions

11.3 cm & 6.8 cm.

Example

(Not to scale!)



- Calculate the area **A** of a board with dimensions

11.3 cm & 6.8 cm.

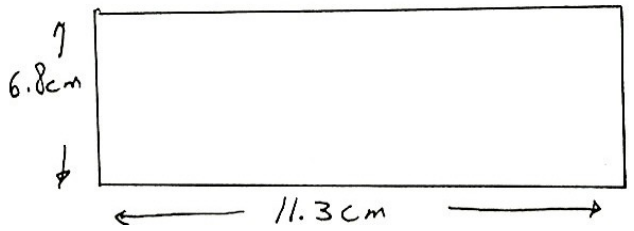
$$A = (11.3) \times (6.8) = 76.84 \text{ cm}^2$$

11.3 has 3 sig figs & **6.8** has 2 sig figs

$\Rightarrow$ **A** has too many sig figs!

Example

(Not to scale!)



- Calculate the area **A** of a board with dimensions

11.3 cm & 6.8 cm.

$$A = (11.3) \times (6.8) = 76.84 \text{ cm}^2$$

11.3 has 3 sig figs & **6.8** has 2 sig figs

$\Rightarrow$ **A** has too many sig figs!

Proper number of sig figs in the answer = 2

$\Rightarrow$ Round off **76.84** & keep only 2 sig figs

$\Rightarrow$ A ***Reliable Answer*** for $A = 77 \text{ cm}^2$

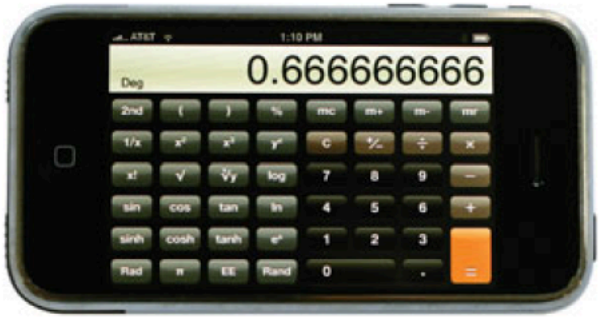
Sig Figs

General Rule

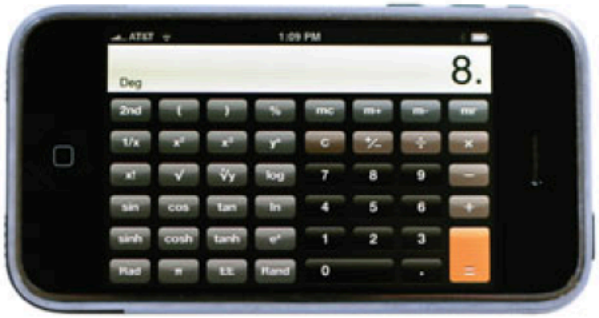
- The final result of a multiplication or division should have only as many sig figs as the number used in the calculation which has the with least number of sig figs.

NOTE!!!!

All digits on your calculator are ***NOT*** significant!!



(a)



(b)

FIGURE 1–6 These two calculations show the wrong number of significant figures. In (a), 2.0 was divided by 3.0. The correct final result would be 0.67. In (b), 2.5 was multiplied by 3.2. The correct result is 8.0.

Calculators will ***not*** give you the right number of significant figures; they usually give too many, but sometimes give too few (especially if there are trailing zeroes after a decimal point).

The top calculator shows the result of **2.0 / 3.0.**

The bottom calculator shows the result of **2.5 × 3.2.**

Conceptual Example 1-2: Significant figures

- Using a protractor, you measure an angle of **30°.**

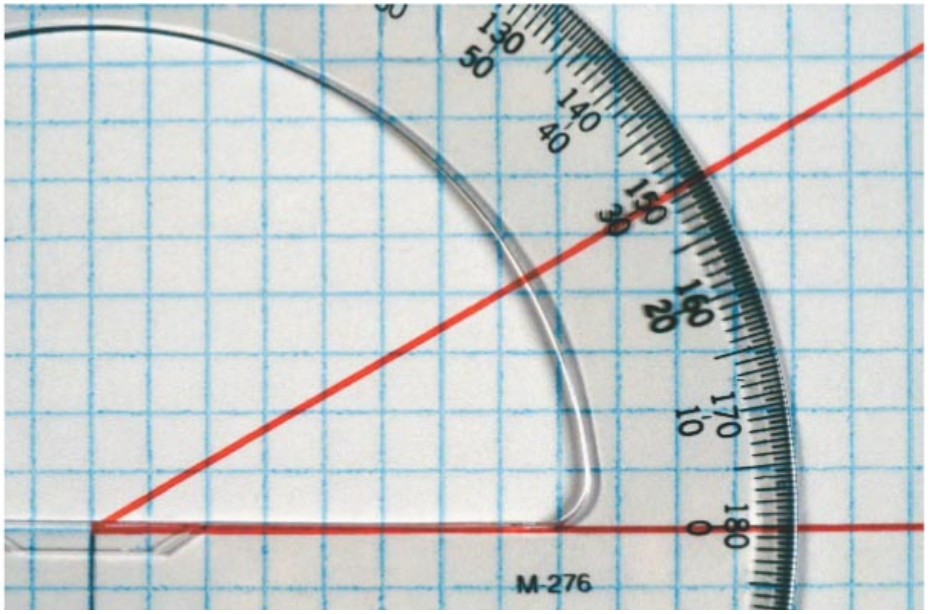
(a) How many significant figures should you quote in this measurement?

(b) Use a calculator to find the cosine of the angle you measured.

(a) Precision ~ 1° (not 0.1°).

So 2 sig figs & angle is 30° (not 30.0°).

(b) Calculator: cos(30°) = 0.866025403. But angle precision is 2 sig figs so answer should also be 2 sig figs. So cos(30°) = 0.87



Powers of 10 (Scientific Notation)

- ***READ*** **Appendices A-2 & A-3**
- It is common to express very large or very small numbers using **power of 10 notation**.
- Examples:

$$39{,}600 = 3.96 \times 10^{4}$$

(moved decimal 4 places to left)

$$0.0021 = 2.1 \times 10^{-3}$$

(moved decimal 3 places to right)

PLEASE USE SCIENTIFIC NOTATION!!

Accuracy vs. Precision

- ***Accuracy*** is how close a measurement comes to the accepted (true) value.
- ***Precision*** is the repeatability of the measurement using the same instrument & getting the same result!

It is possible to be accurate without being precise and to be precise without being accurate!