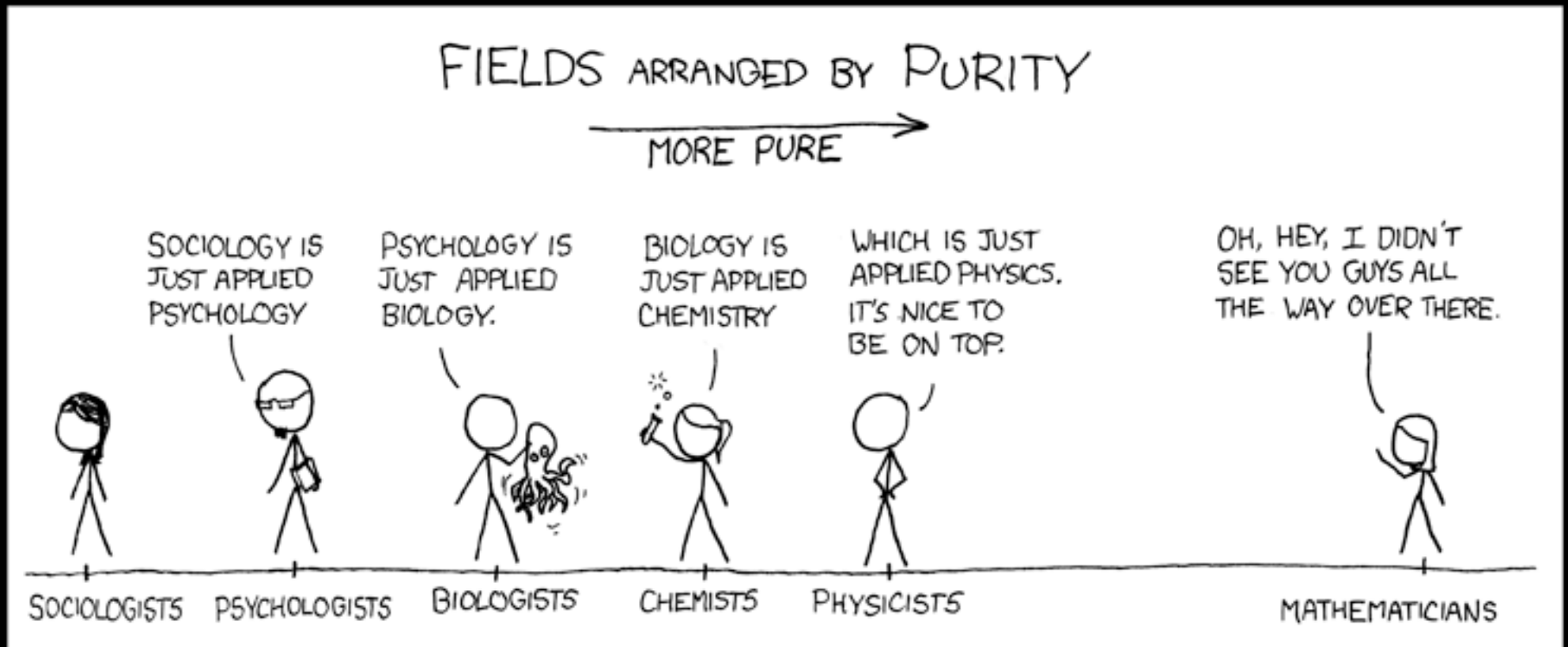


What is Physics?



- Physics describes matter, energy, space, and time at the most fundamental level.
- Physics is the foundation for all other fields of science, and uses mathematics to attempt to describe all natural phenomena, from atomic structure to the origin of the universe

Why is Physics hard?

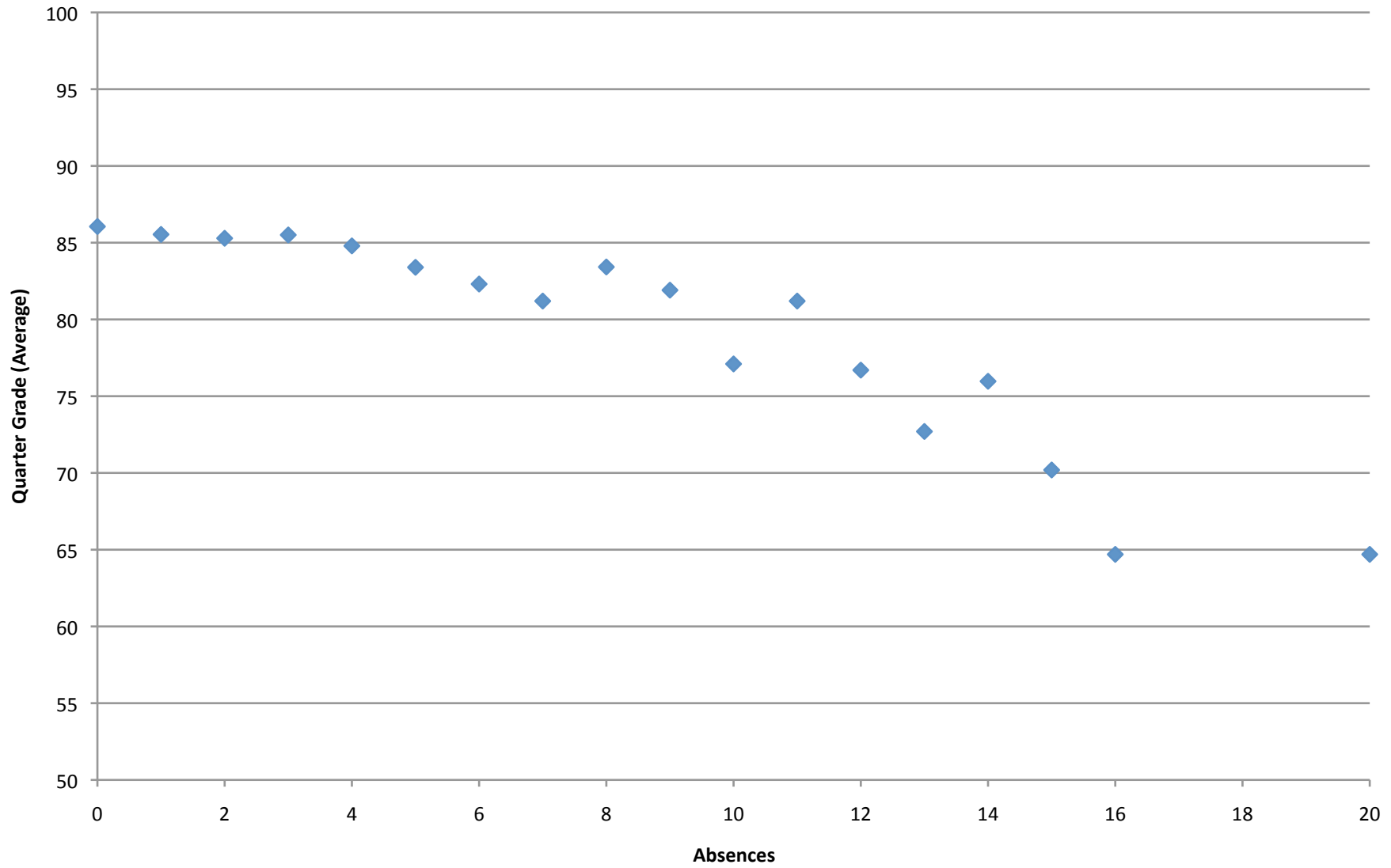
- Physics makes you take general ideas and apply them to new or unfamiliar situations
- Physics uses math to analyze scenarios in word problems
- Physics requires a certain level of creativity
- Physics requires strong spacial skills
- Physics challenges many preconceived notions and misconceptions
- Physics requires you to remember things you already “learned”
- Physics uses the metric system

How to Make Physics Harder

- Don't bother to do the assigned homework
- Copy homework and class problems from a friend without doing them out yourself
- Don't show your work on problems
- Don't bother with those pesky units
- Don't take notes, and definitely don't copy examples done in class
- Don't ask questions, and don't stay for extra help
- Leave your calculator in radian mode when working with angles
- Go on as many field trips, band trips, sports trips, choir trips, and ski trips you can possibly arrange

Education is NOT a spectators sport. Learn by doing.

09-10: Average Quarter Grade vs. Absences



The Trouble with Variables

- The English alphabet has 26 letters, but there are more than 26 measurable quantities that are represented by variables.
 - The same letter may represent different quantities
 - Example: T is the variable for both temperature and period
 - Greek letters are also often used
- Capital and lowercase variables usually represent different quantities
 - Example: $v \rightarrow$ velocity $V \rightarrow$ volume

“What does ‘m’ mean?”

- A letter can have many different meanings depending on the context in which it is used.

Context	‘m’ means...
$y = mx + b$	the variable for slope
$\Sigma F = ma$	the variable for mass
5 m	the unit “meters”
12 mg	the prefix “milli-”

Units

- Every measured quantity must have a unit associated with it
- We will mainly use SI units in this course:

Measurement	Unit
Length	meter (m)
Mass	kilogram (kg)
Time	second (s)
Electric Current	ampere (A)
Temperature	Kelvin (K)
Amount of substance	mole (mol)
Brightness	candela (cd)

Units

Metric Prefixes

- Most common prefixes we will use:

Prefix	Symbol	Factor	Example
kilo-	k	$10^3 = 1000$	1 kilogram (kg) = 1000 grams
centi-	c	$10^{-2} = 0.01$	1 centimeter (cm) = 0.01 meters
milli-	m	$10^{-3} = 0.001$	1 milliliter (mL) = 0.001 liter
micro-	μ (“mu”)	$10^{-6} = 0.000001$	1 microsecond (μ s) = 0.000001 seconds

Units

Unit Conversion

- Most quantities can be measured in more than one unit
- Principle behind unit conversion:
 - **Multiplying a quantity by 1 doesn't change it**

Units

Unit Conversion

- Example: 1 mile is equal to 1.6 kilometers.
 - We can use this to create a conversion factor.
 - $1 \text{ mile} = 1.6 \text{ km} \rightarrow 1 = (1 \text{ mile}) / (1.6 \text{ km})$
 - Also, $1 = (1.6 \text{ km}) / (1 \text{ mile})$

Units

Unit Conversion

- Question: How many miles are in a 10K (10 kilometer race)?
- Distance = $(10 \cancel{\text{ km}}) \times \frac{1 \text{ mile}}{1.6 \cancel{\text{ km}}} = 6.25 \text{ miles}$

Tip: Units can be treated like algebraic variables. A unit is cancelled out if it is divided by itself.

Units

Unit Conversion

- Keeping track of units can make multiple conversions easier.
- Q: How many seconds are there in a day?

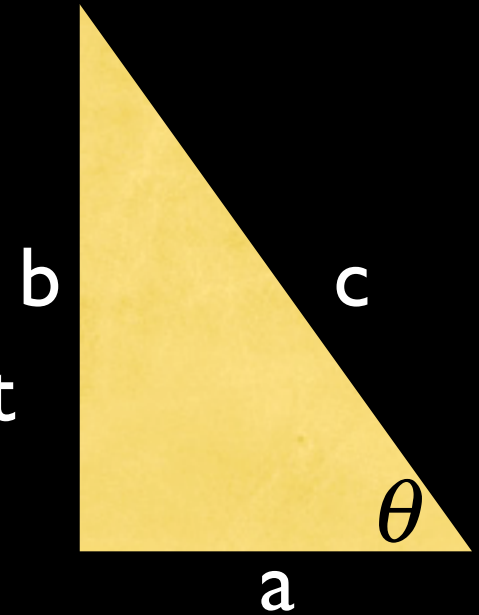
$$\begin{aligned} \text{Time} &= 1 \cancel{\text{ day}} \times \frac{24 \cancel{\text{ hours}}}{1 \cancel{\text{ day}}} \times \frac{60 \cancel{\text{ min}}}{1 \cancel{\text{ hour}}} \times \frac{60 \cancel{\text{ sec}}}{1 \cancel{\text{ min}}} \\ &= 86400 \text{ s} \end{aligned}$$

If the units don't cancel out algebraically, the conversion is wrong!

Trigonometry

Triangle Math

- Sum of angles = 180°
- Area of Triangle = $1/2 \times \text{Base} \times \text{Height}$
- Pythagorean Theorem: $a^2 + b^2 = c^2$
- SOHCAHTOA



$$\sin \theta = \frac{\text{Opposite}}{\text{Hypotenuse}} = \frac{b}{c} \quad \cos \theta = \frac{\text{Adjacent}}{\text{Hypotenuse}} = \frac{a}{c} \quad \tan \theta = \frac{\text{Opposite}}{\text{Adjacent}} = \frac{b}{a}$$

Scientific Notation

- General format: $A \times 10^B$, where $0 < A < 10$
- Exponent denotes number of places decimal was moved
 - Positive if moved left (quantity > 1)
 - Negative if moved right (quantity < 1)

$$5,000 = 5 \times 10^3 \qquad 0.0000004 = 4 \times 10^{-7}$$

$$0.035 = 3.5 \times 10^{-2}$$

Scientific Notation

- Adding & Subtracting:
 - If exponents agree, add coefficients and attach power of ten

$$3 \times 10^6 + 2 \times 10^6 = 5 \times 10^6$$

“3 million plus 2 million equals 5 million”

- If exponents don't agree you must convert so that exponents agree

Scientific Notation

- Multiplying & Dividing:
 - You can treat the coefficients and powers of ten separately to simplify the math
 - $10^n \times 10^m = 10^{n+m}$
 - $10^n \div 10^m = 10^{n-m}$
 - $1/10^n = 10^{-n}$

Scientific Notation

- Multiplying & Dividing:

$$(2 \times 10^6)(3.5 \times 10^3) = (2 \times 3.5)(10^6 \times 10^3) = 7 \times 10^9$$

$$\frac{9 \times 10^7}{2 \times 10^4} = \frac{9}{2} \times \frac{10^7}{10^4} = 4.5 \times 10^3$$

$$\frac{(3 \times 10^5)(6 \times 10^2)}{2 \times 10^{10}} = \frac{3 \times 6}{2} \times \frac{10^5 \times 10^2}{10^{10}} = 9 \times 10^{-3}$$

You can do quick estimations by just looking at the exponents in your calculations.

Using Your Calculator

The “EE” Button

- Scientific & Graphing calculators handle scientific notation using the “E” or “EE” button
- “E” means “times 10 to the...”
- If your calculator says... “4E7”
 - It means “ 4×10^7 ”

Do not confuse “EE” with “ e^x ”...these are two very different functions.

Using Your Calculator

The “EE” Button

- Common Mistakes:
 - $4E^6$ -> Syntax Error
 - $4E10^6$ -> This means “ $4 \times 10^{10^6}$ ” = 4.096×10^{63}
 - $4 \times 10E6$ -> This means “ $4 \times 10 \times 10^6$ ” = 4×10^7

The “EE” button makes your life easier! Don't over complicate it!!