WHAT IS PHYSICS?

DICTIONARY DEFINITION

- PHYS•ICS
- /ˈFIZIKS/
- NOUN

  - the branch of science concerned with the nature and properties of matter and energy. The subject matter of physics, distinguished from that of chemistry and biology, includes mechanics, heat, light and other radiation, sound, electricity, magnetism, and the structure of atoms.

OUR DEFINITION

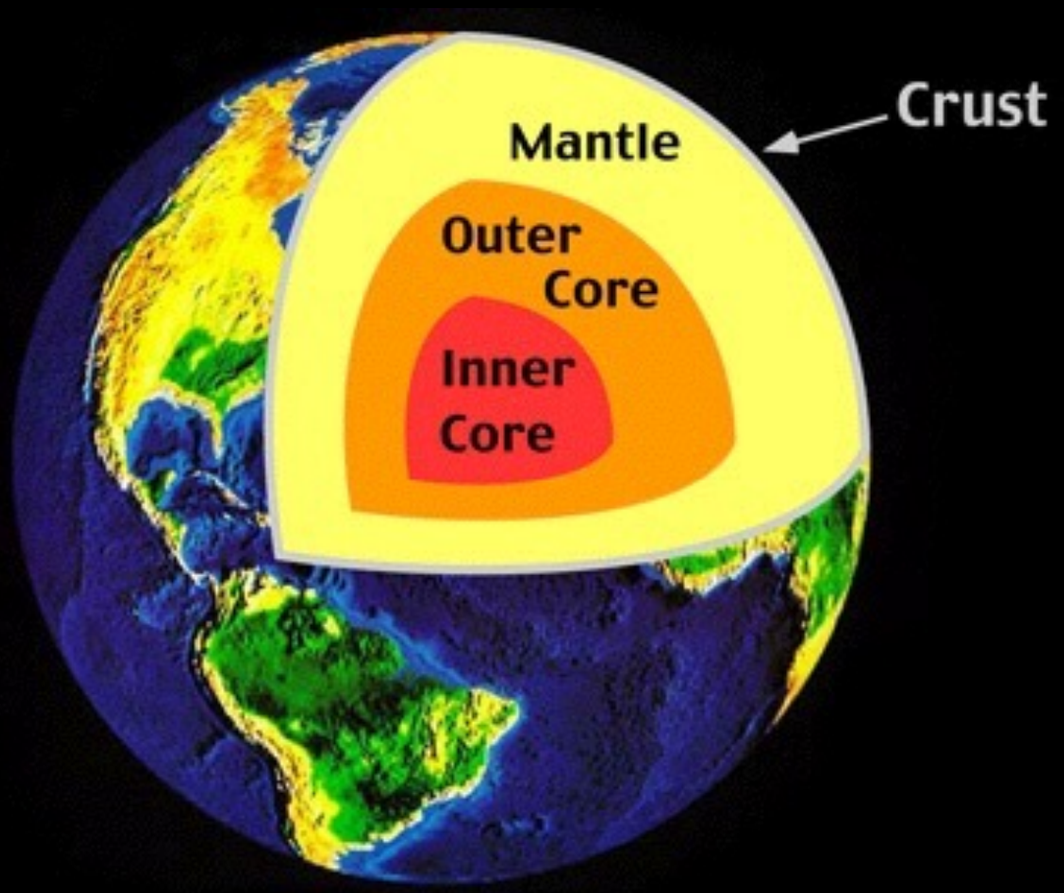
- Physics is the branch of science consisting of the fundamental principles upon which the physical world is built

HOW DO WE KNOW WHAT WE KNOW?

"The most exciting phrase to hear in science, the one that hails new discoveries, is not 'Eureka!' but 'That's funny…'" — Isaac Asimov

THE COMPOSITION OF EARTH

- Outer Crust
  - 30-40 km thick
- Mantle
  - 2,900 km thick
  - silicate rocks + magnesium and iron
- Outer Core
  - 2,300 km thick
  - liquid iron-nickel-sulfur
- Inner Core
  - radius of 1,200 km
  - solid iron-nickel alloy
  - 10,800 °F (as hot as the surface of the Sun!)



THE DEEPEST HOLE IN THE WORLD

- Kola Superdeep Borehole
- Kola Peninsula, Russia
- 12,262 meters (40,230 ft) deep!
- https://www.youtube.com/watch?v=zz6v6OfoQvs

THIS BEGS THE QUESTION…

- If we've never even come close to visiting the inner layers of Earth, how do we know what's there?

IN THIS CLASS, WE WILL...

- Learn to see the unseen, and in some case the unseeable

- Gain the tools to understand the inner-workings of the physical world

- Acquire a foundational knowledge upon which the Universe has been built

- (How *do* we know what the Earth is made of? To find out, click here)

MOST IMPORTANT RULE IN SCIENCE

- Ask questions!
- It’s the only way we learned any of this to begin with

S.I. UNITS, SIGNIFICANT FIGURES, AND SCIENTIFIC NOTATION

THE COMMON LANGUAGE OF SCIENCE

S.I. UNITS

- Common, agreed upon units of measurement
- Length: meter (m)
- Mass: kilogram (kg)
- Electric current: ampere (A)
- Temperature: kelvin (K)
- Time: second (s)
- And a bunch of derived units that we'll learn as we go along

METRIC PREFIXES

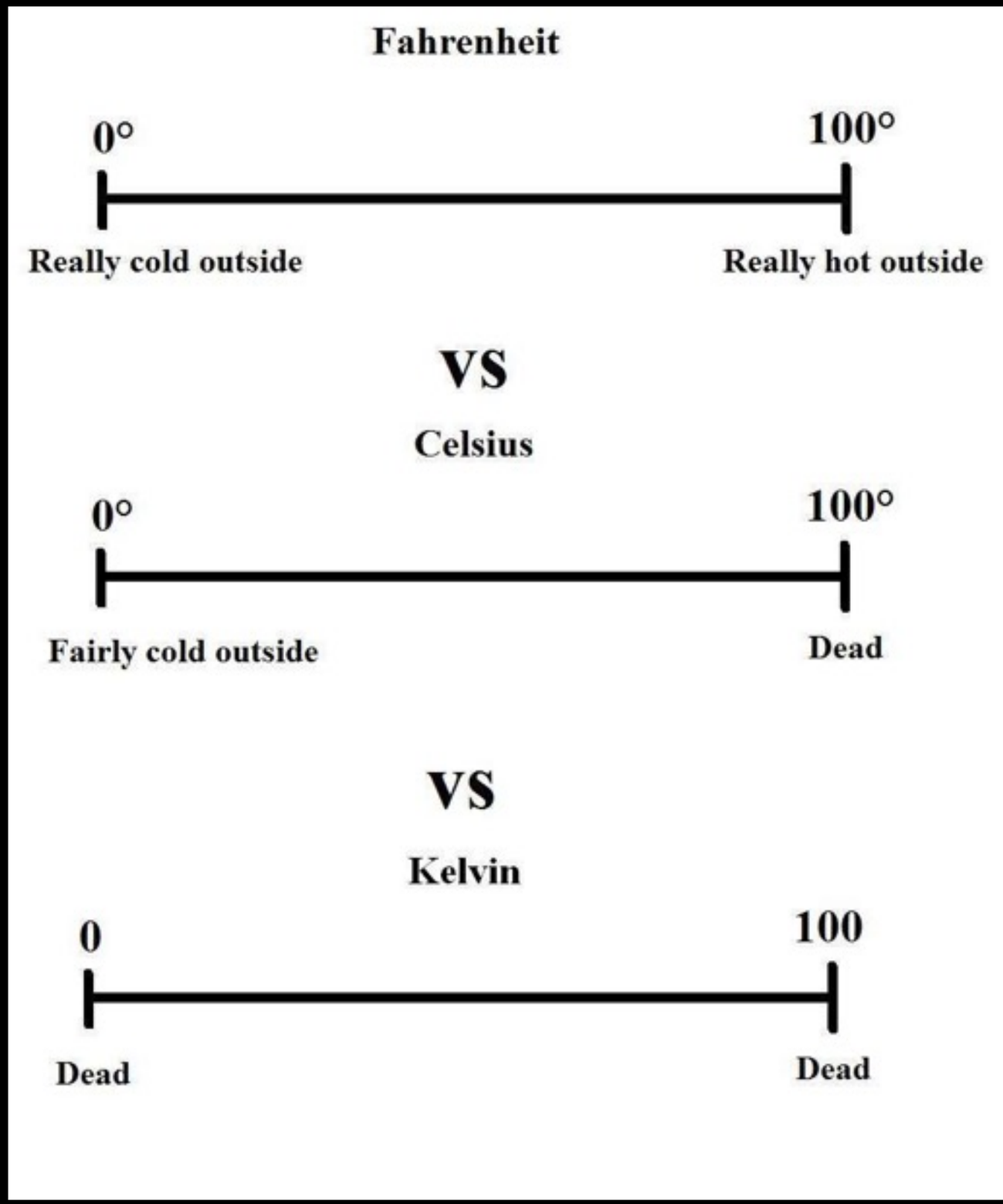
PREFIX	ABBREVIATION	VALUE
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	**M**	**10^{6}**
kilo	**k**	**10^{3}**
hecto	h	10^{2}
deka	da	10^{1}
deci	d	10^{-1}
centi	**c**	**10^{-2}**
milli	**m**	**10^{-3}**
micro	**μ**	**10^{-6}**
nano	**n**	**10^{-9}**
pico	**p**	**10^{-12}**
femto	f	10^{-15}
atto	a	10^{-18}

CONVERTING UNITS

- 1 m = 100 cm = 1000 mm = 0.001 km
- 1 g = 100 cg = 1000 mg = 0.001 kg
- 100 km/hr = ? m/s

CURB YOUR INTUITION

- Establish new reference points
- When you hear “26 °C,” instead of thinking “That’s 79 °F” think “That’s warmer than a house but a little cool for swimming”



CURB YOUR INTUITION

TEMPERATURE	
60°C	Earth's hottest
45°C	Dubai heat wave
40°C	S. US heat wave
35°C	N. US heat wave
30°C	Beach weather
25°C	Warm room
20°C	Room
10°C	Jacket weather
0°C	Snow!
-5°C	Cold day (Boston)
-10°C	Cold (Moscow)
-20°C	itscolditscolditscold
-30°C	Aaaaggggghhhh!
-40°C	Spit goes "click"

LENGTH	
1 cm	Width of mircoSD
3 cm	Length of SD card
12 cm	CD diameter
15 cm	BiC pen
80 cm	Doorway width
1 m	Lightsaber blade
170 cm	Summer Glau
200 cm	Darth Vader
2.5 m	Ceiling
5 m	Car-length
16.04 m	Human tower of the *Serenity* crew

MASS	
3 g	Peanut M&M
100 g	Cell phone
500 g	Bottled water
1 kg	MacBook Air
2 kg	15" MacBook Pro
3 kg	Heavy Laptop
5 kg	LCD monitor
15 kg	CRT monitor
4 kg	Cat
60 kg	Lady
70 kg	Dude
150 kg	Shaq
200 kg	Your mom

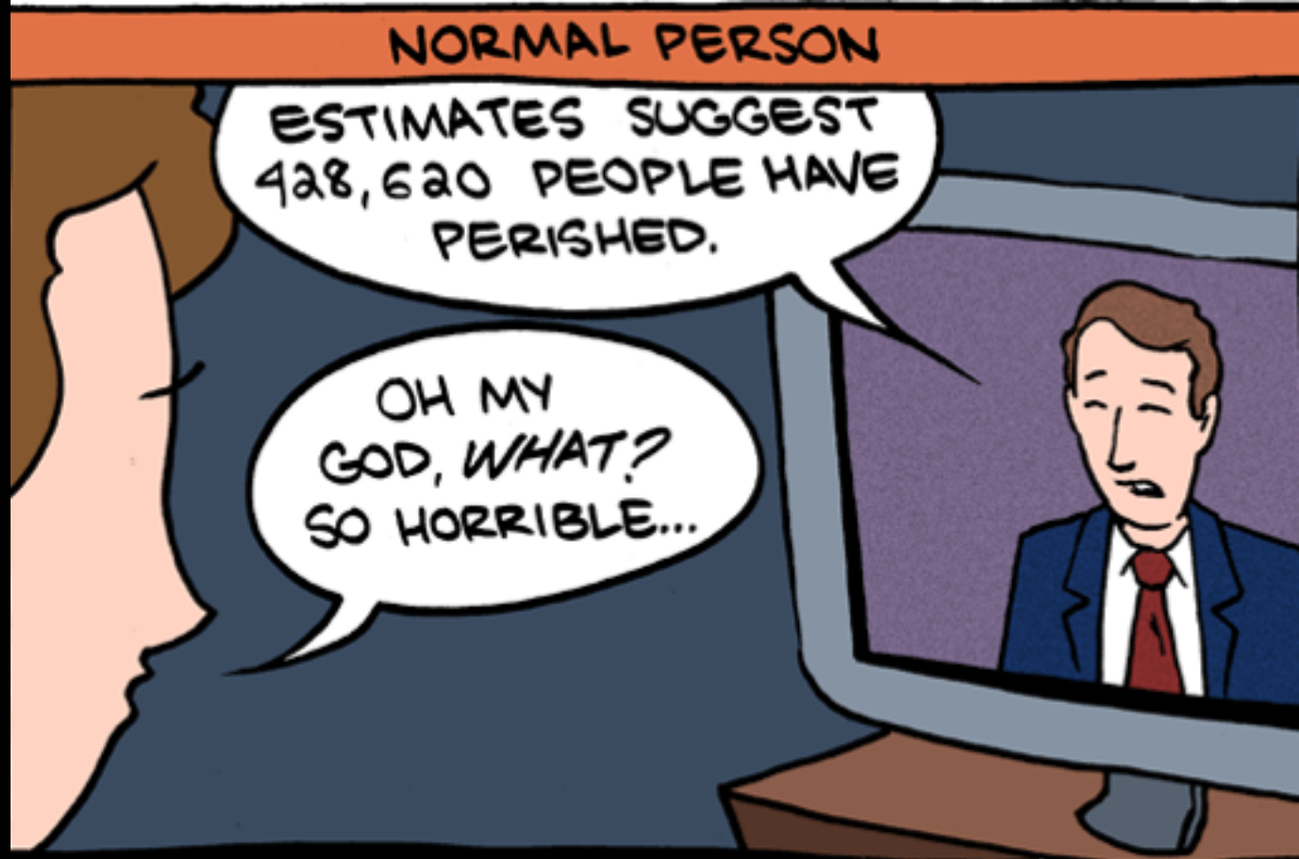
PAY ATTENTION TO UNITS

- Know what units you're working in and don't forget to convert to SI!

- http://www.cnn.com/TECH/space/9909/30/mars.metric.02/

SIGNIFICANT FIGURES

- The number of reliably known digits in a number is called the number of **significant figures**
- Tells you how accurately you know a know a number
- It's the difference between saying the downtown LA is *about* 10 miles away and saying DTLA is *exactly* 12.7 miles away
- Or is DTLA more accurately 12.733 miles away?



SIGNIFICANT FIGURES

- 10 has one sig fig
- 12.7 has three sig figs
- 12.733 has five sig figs
- 0.062 has two sig figs
    - The zeros here merely act as a place holder to show where the decimal goes
- 80.0 has three sig figs
    - Now those last zeros are significant because it says that we know this value to the accuracy of the tenths place

SIG FIGS IN CALCULATIONS

- Rule 1: Multiplying and Dividing
  - **The answer should only have as many sig figs as the number with the least number of sig figs used in the calculation**
  - E.g. Find the area of a rectangle with sides 11.3 cm and 6.8 cm
    - You plug in 11.3 × 6.8 and your calculator spits out 76.84
    - But there's no way you actually know the area of the rectangle to an accuracy of 0.01 cm^2
    - Taking sig figs into account, round off your answer to 77 cm^2

SIG FIGS IN CALCULATIONS

- Rule 2: Adding and Subtracting
  - **The answer can contain no more decimal places than the least accurate measurement.**
    - E.g. You tie a 30.6-m-long rope to the end of a 0.57-m-long rope. How long are the two ropes together?
    - Round off your answer to 31.2 m (*not 31.17 m*)

EXCEPTION

- Rules of sig figs don’t apply to countable numbers
- If you have a jar of 1,000 marbles, assuming you actually went and counted them, you know there are *exactly* 1,000 marbles
- Then, if you dividing the marbles equally between 4 friends, you can safely say that each person as 250 marbles

MORAL OF THE STORY

- When making calculations, you will *never* get a result that is more accurate than the information that you started off with

SCIENTIFIC NOTATION

- Instead of writing 1,540,000 m, you write 1.54×10^{6} m
- Instead of writing 0.0000448 kg, you write 4.48×10^{-5} kg
- Usually cleaner and easier to read