General Physics I

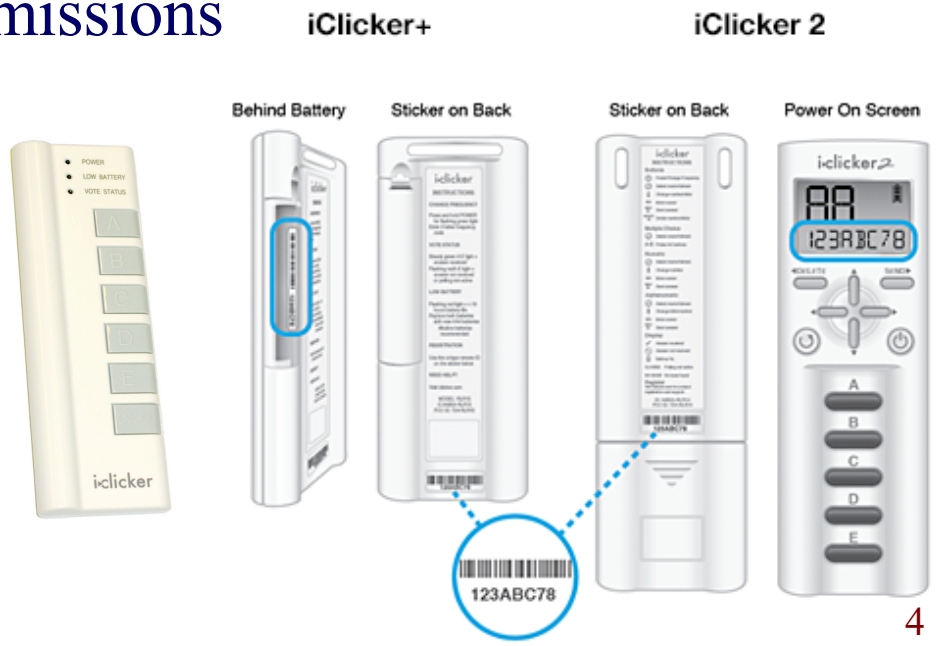
Math Warm-Up (Appendix A)
Measurements & Units
Coordinates & Speed (Ch 1, Secs 1-2)

Day 1, Video 1

Class Particulars, Syllabus & Materials

Class Business

- Class resources at https://learninghub.andrews.edu
  - Textbook
  - Homework, Lecture Slides, Test Study Materials
  - Lab Videos, Instructions & Submissions
  - iClicker Registration
- Materials
  - Textbook
  - iClicker
  - Scientific or graphing calculator



Day 1, Video 2

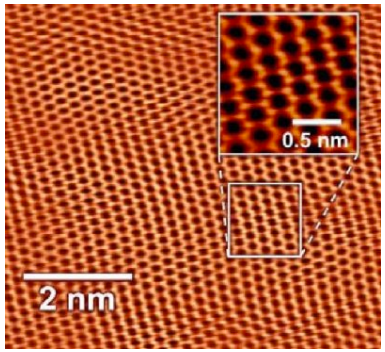
Intro to Physics

Scientific Notation & Math Rev 1

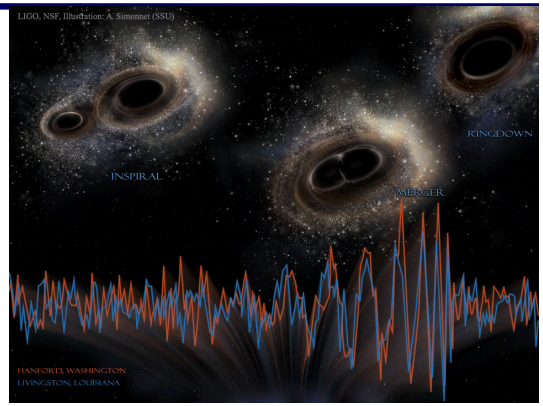
Question #1

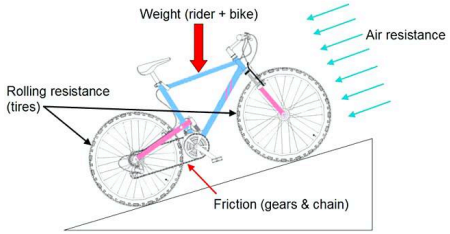
- My favorite fundamental force is
  - A. Gravity
  - B. Electro-Magnetic
  - C. Strong Nuclear
  - D. Weak Nuclear

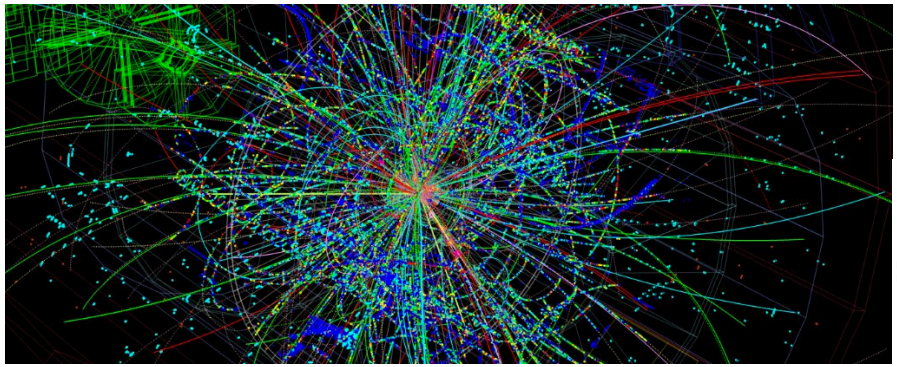
What is Physics?

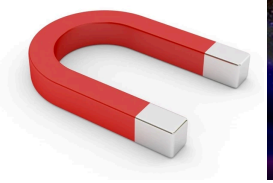


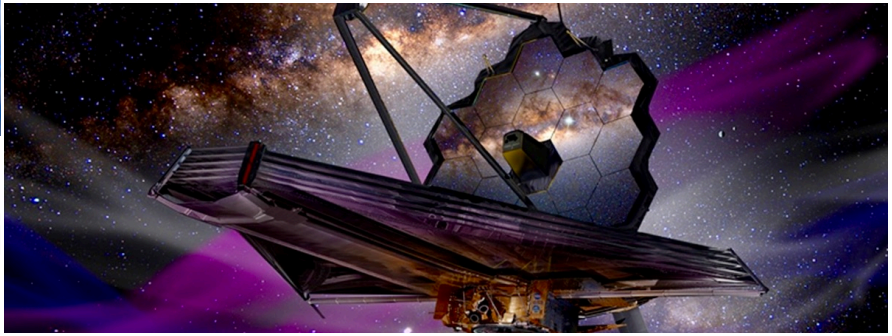
- Most fundamental of the sciences
- Building models to describe the physical world
- The study of …
  - Motion, Forces, Heat, Energy, Sound, Electricity & Magnetism, Light, Optics, Materials, Atoms, Nuclei, Particles, Spacetime, Stars, The Cosmos, etc.











Scientific Notation

$10^0 = 1$ $\qquad$ $10^{-1} = 0.1$

$10^1 = 10$ $\qquad$ $10^{-2} = 0.01$

$10^2 = 100$

$3 \times 10^2 = 300.$ $\qquad$ $6 \times 10^{-2} = 0.06$

Decimal moves to right $\qquad$ Decimal moves to left

$$(3\times10^6)(4\times10^4) = (3\cdot4)\times10^{6+4} = 12\times10^{10} = 1.2\times10^{11}$$

$$\frac{6\times10^6}{3\times10^4} = \frac{6}{3}\times10^{6-4} = 2\times10^2$$

Algebra

- Natural exponents / logarithms

$4 = e^x$ ← Undo with ln

$\ln(4) = \ln(e^x)$

$1.39 = x$

$\ln x = 3$ ← Undo with e

$e^{\ln x} = e^3$

$x = 20.1$

Question #2

$$\frac{e^{x}-1}{2}=1$$

- What is the value of x?

A. 0.41

B. 1.10

C. 4.48

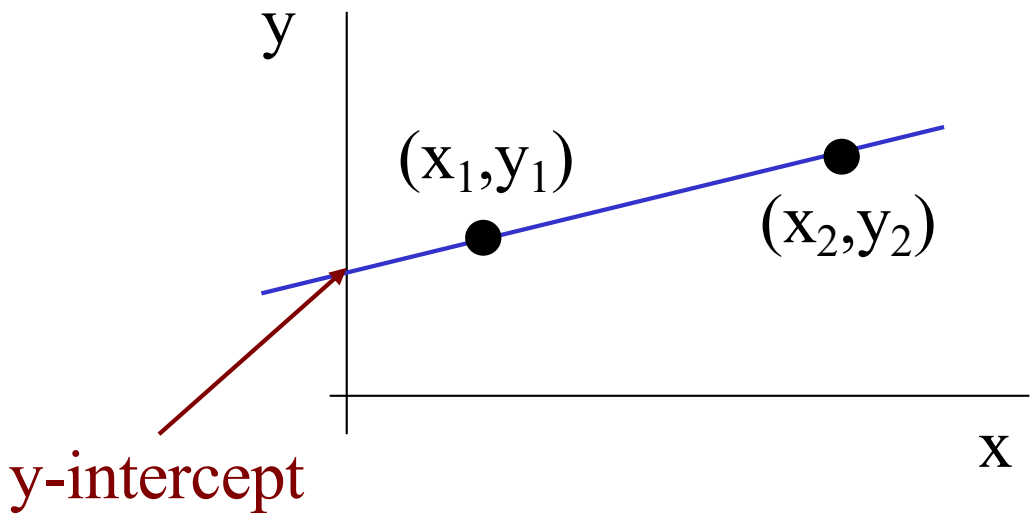
D. 20.1

Linear Equations

$$y = mx + b$$

slope y-intercept

$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$



Question #3

- The Slope of the Line is:

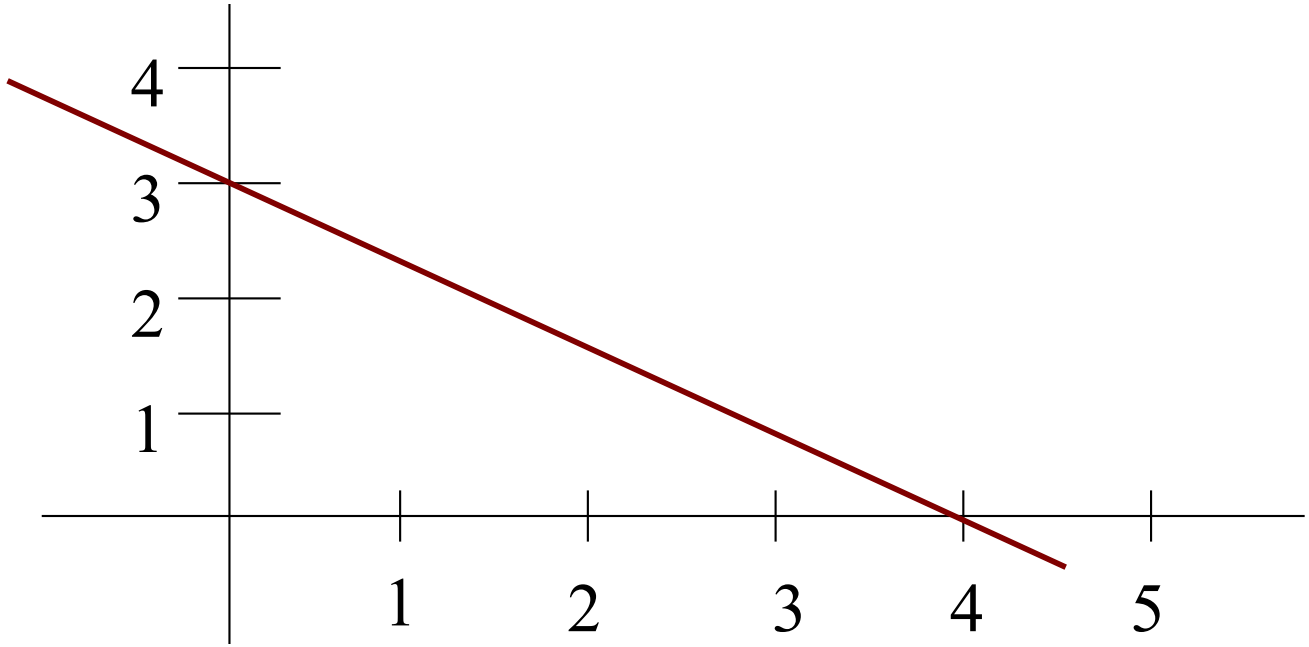
A.-3

B.-0.75

C.4

D.0.75

E.1.25



Day 1, Video 3

Math Rev 2

Quadratic Equations

$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

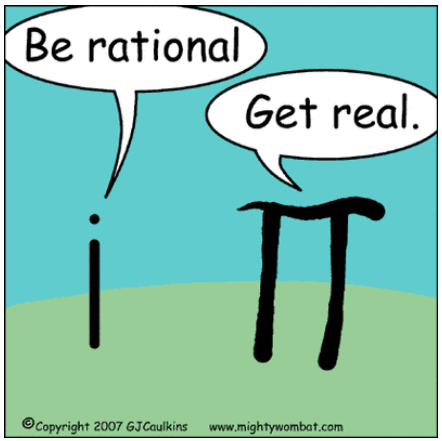
Example:

$$4x^2 + 10x + 1 = 0$$

a b c

If b^2 - $4ac$ is negative, answer is imaginary

$$\frac{-8 \pm \sqrt{-16}}{2} = -4 \pm \tfrac{1}{2}\left(\sqrt{16}\right)i = -4 \pm 2i$$



Question #4

- Which of the following is a solution to the quadratic equation $x^2 + 2x - 3 = 0$

A. -1

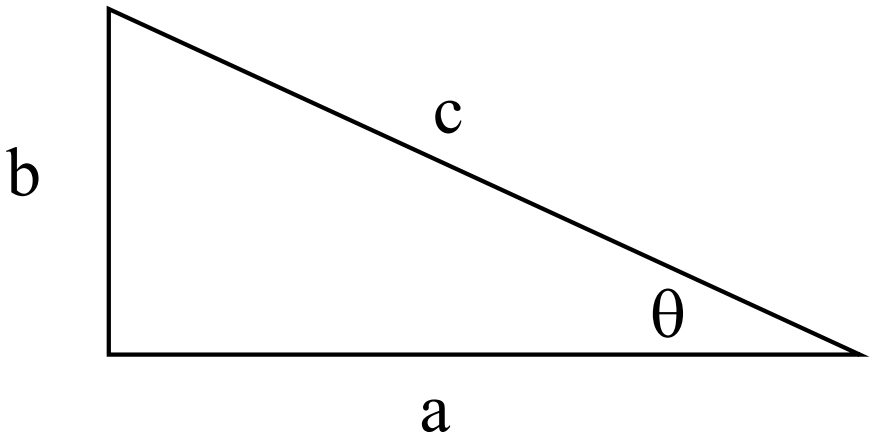
B. 0

C. -3

D. 4

E. 12

Trigonometry



$$\sin\theta = \frac{b}{c} = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\cos\theta = \frac{a}{c} = \frac{\text{adjacent}}{\text{hypotenuse}}$$

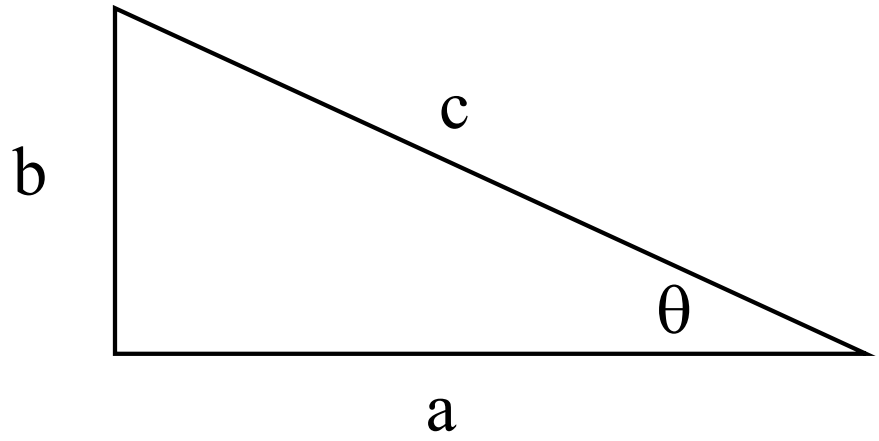
$$\tan\theta = \frac{b}{a} = \frac{\text{opposite}}{\text{adjacent}}$$

$$a^2 + b^2 = c^2$$

Question #5

- What is θ if b=2 and a=3?

A. 1.5°
B. 27.3°
C. 30.1°
D. 33.7°
E. 41.8°

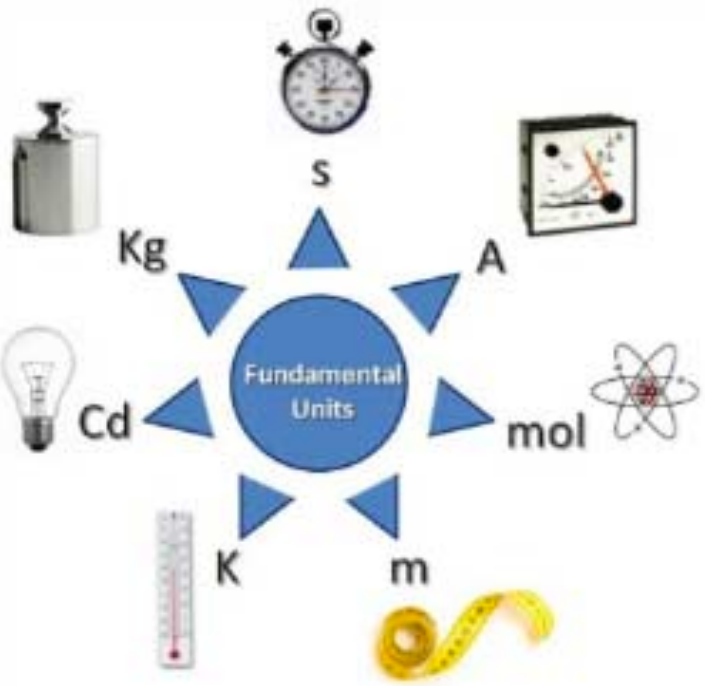


Day 1, Video 4

Units

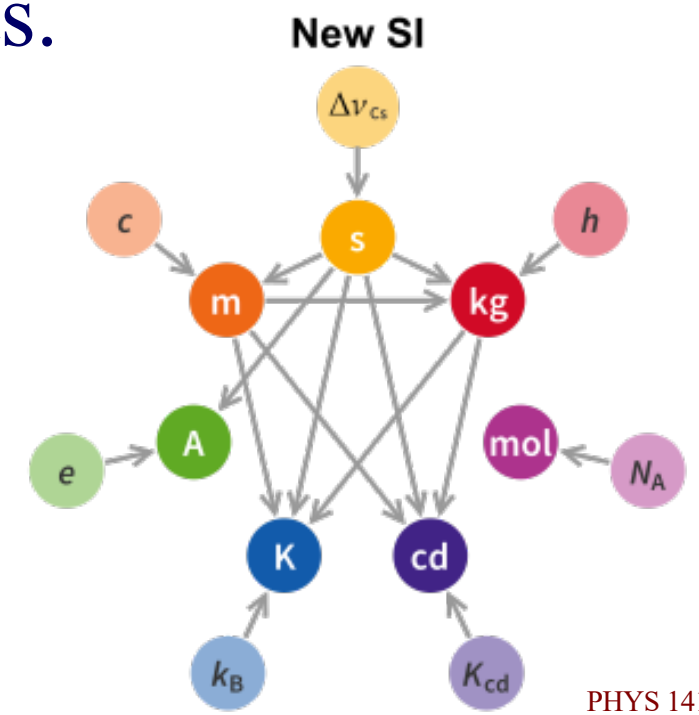
Tools of Physics - Units

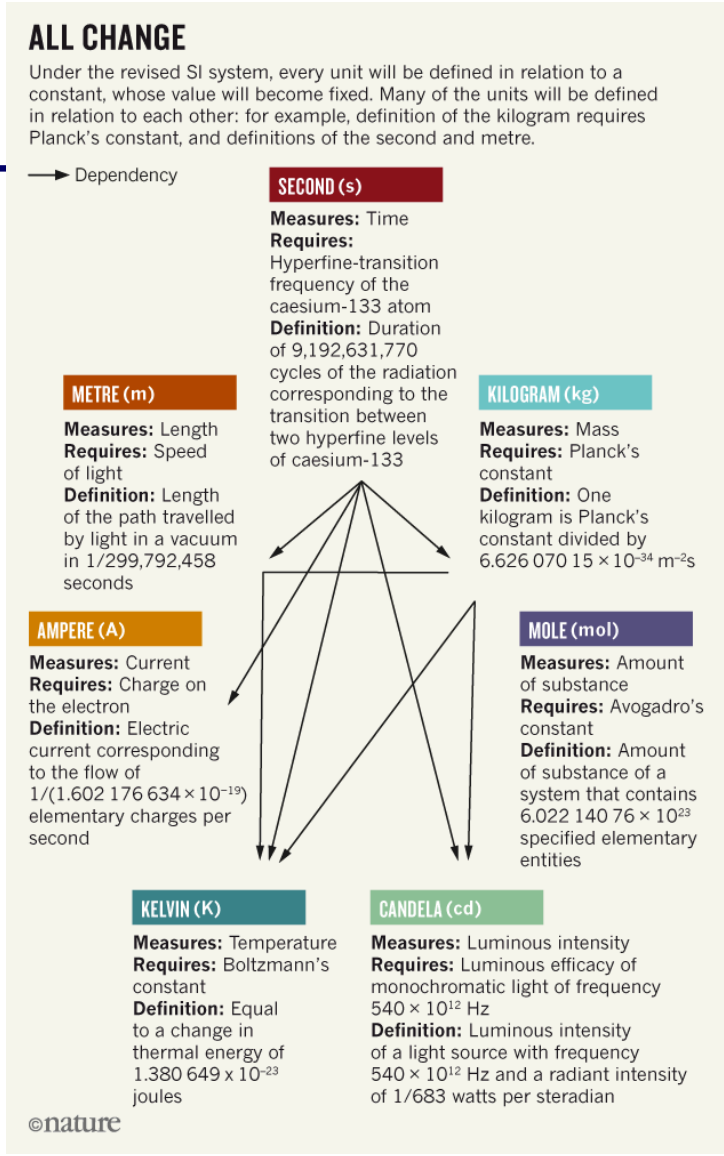
- Physical quantities (volume, distance, speed, etc.) expressed in units
- All units can be expressed in terms of the **fundamental units**
  - Area = Length^2, Speed = Length / Time



The New SI

- May 20, 2019 was a BIG DAY
- New definitions of fundamental SI units.





Tools of Physics - Units

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

Unit Prefixes

1 centimeter = 1×10^{-2} = 0.01 meters

3 kilometers = 3×10^{3} = 3000 meters

Tools of Physics – Unit Conversion

You pour a glass of milk in 5.0 seconds
Convert to cm^3/min

$$\frac{1 \text{ glass}}{5.0 \text{ Seconds}} = 0.20 \text{ glasses / second}$$

Don't forget exponents with squared, cubed units!

$$\frac{0.20 \text{ glasses}}{\text{second}}\left(\frac{2 \text{ cups}}{1 \text{ glass}}\right)\left(\frac{1 \text{ gallon}}{16 \text{ cups}}\right)\left(\frac{231 \text{ in}^3}{1 \text{ gallon}}\right)\left(\frac{2.54 \text{ cm}}{1 \text{ in}}\right)^3\left(\frac{60 \text{ seconds}}{1 \text{ min}}\right) = 5.7\times10^3 \text{ cm}^3 / \text{min}$$

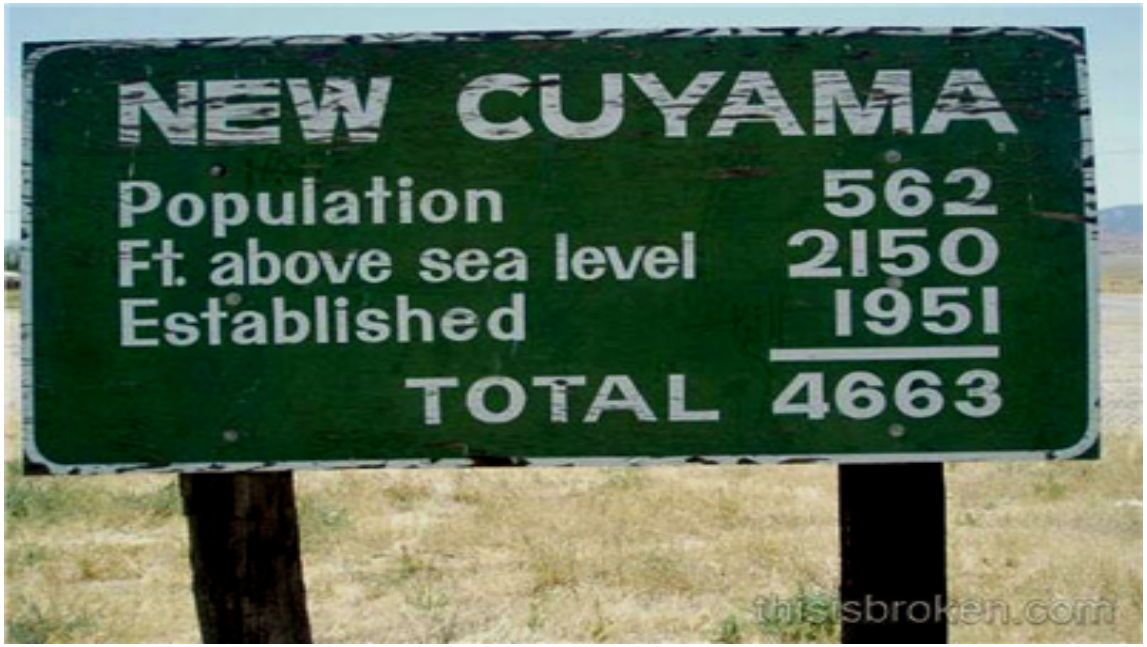
Question #6

- A camel can drink 20 gallons of water at a time. Suppose you have 600 liters of water. How much water is this in camels? (Hint: 1gallon = 3.786 liters)

A. 2.45
B. 7.92
C. 10.0
D. 80.5

Tools of Physics – Dimensional Analysis

- It is important that units agree



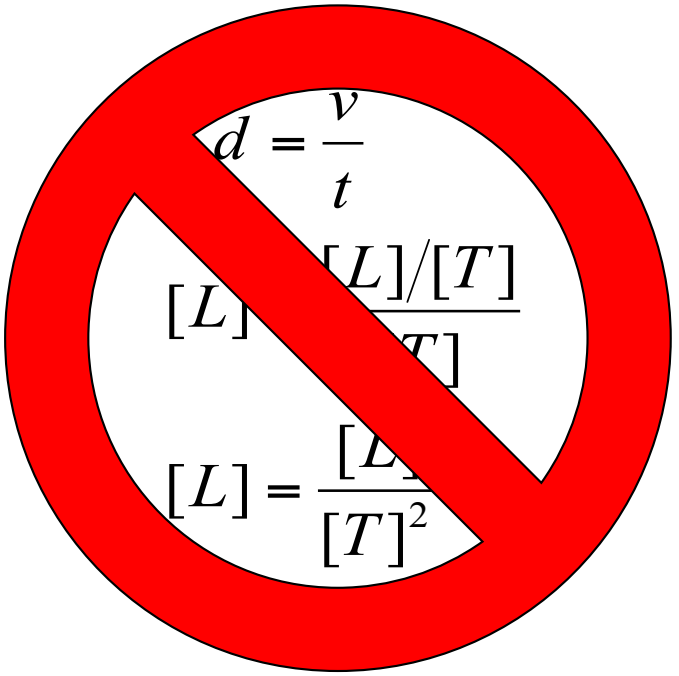
Tools of Physics – Dimensional Analysis

- Handy for equation checking
  - Both sides of an equation should have matching units

$$d = \tfrac{1}{2}at^2$$

$$[L] = \frac{[L]}{[T]^2}[T]^2$$

$$[L] = [L]$$



Question #7

- Which of the following could be correct?

A. $v = v_0 + at^2$ (v = velocity, a = acceleration)

B. $V = Ah$ (V = volume, A = area, h = height)

C. $ma = v^2$ (m = mass, a = acceleration, v = velocity)

- Hint, SI units for: velocity=m/s, acceleration=m/s^2, volume=m^3, area=m^2, height=m, mass=kg

Day 1, Video 5

Sig Figs & Estimation

Question #8

- How long is the chocolate bar?

A. 4.38 cm
B. 4.39 cm
C. 4.40 cm
D. 4.41 cm
E. 4.42 cm

Tools of Physics – Sig. Figs

- All measurements involve uncertainty
- Addition / Subtraction – keep digits to smallest common significant decimal place
- Multiplication / Division – same as factor with smallest number of significant digits

$$\begin{array}{r} 13.062 \\ +\ 0.13 \\ \hline 13.19 \end{array}$$

$$(0.012)(1.630\times10^{3}) = 2.0\times10^{1}$$

Tools of Physics - Sig. Figs

- Counting Sig Figs
  - Rules are different for digits to the left and right of the decimal pt
  - Placeholders don't count, zeros that specify accuracy do (Is it necessary?)

Left		Right	
120	(2 sig figs)	0.12	(2 sig figs)
120.0	(4 sig figs)	0.012	(2 sig figs)
120.	(3 sig figs)	0.120	(3 sig figs)
1.20×10^2	(3 sig figs)		

Question #9

$$0.023 \times 1.00$$

- Which answer has the correct number of sig figs?

A. 0
B. 0.02
C. 0.023
D. 0.0230
E. 0.02300

Estimation

- Find out what the order of magnitude of something might be
  - Make educated guesses of quantities
  - Do calculations based on these guesses
  - Round to nearest power of 10

Question #10

- Estimate your age in months

A. 10^0

B. 10^1

C. 10^2

D. 10^3

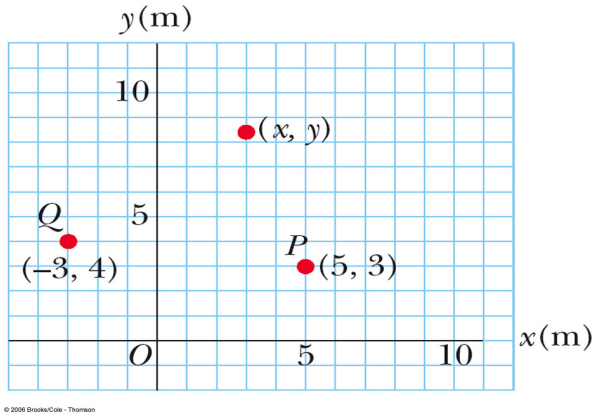
E. 10^4

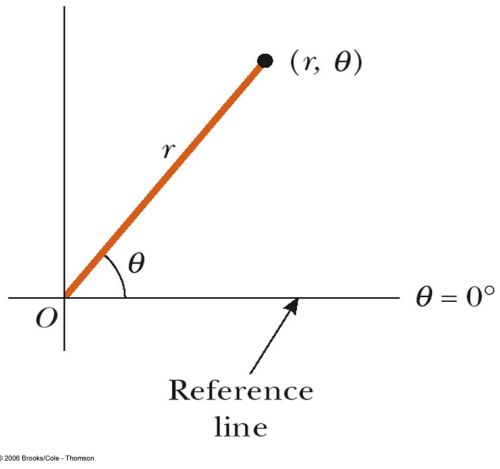
Day 1, Video 6

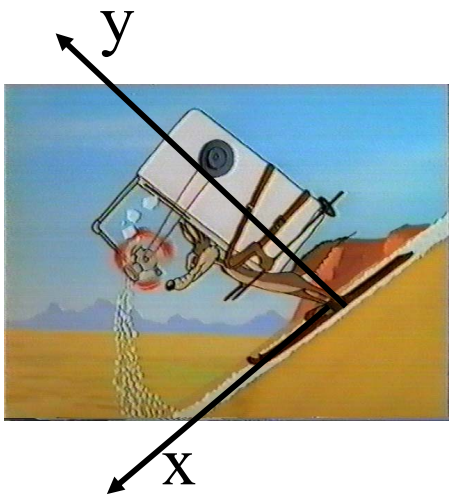
Coordinate Systems, Path Length & Speed

Tools of Physics – Coordinate Systems

- Directions and positions of events & objects specified by **coordinate systems**
  - Origin plus coordinates / axes
- Choice of coordinate system up to the problem solver – choose a system that simplifies your problem

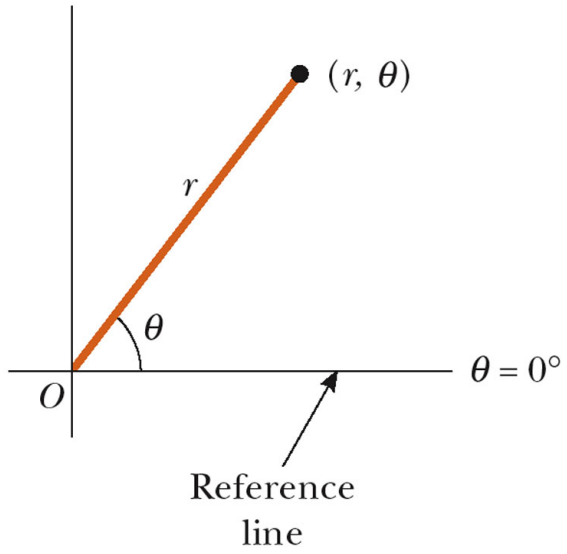






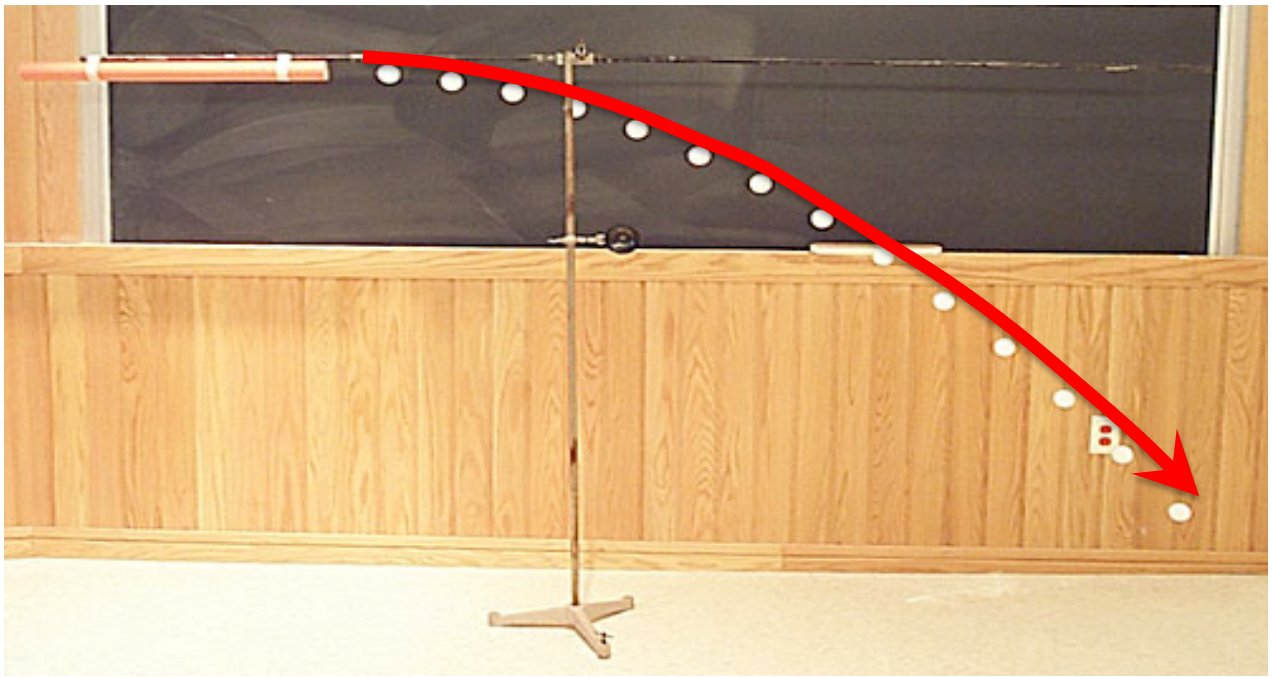
Example 1

- A point in radial coordinates is r = 5 cm and θ = 32º. What are the x and y coordinates of this point?



Path Length

- Distance covered by a moving object s(t)



Speed

- How fast is an object moving along its path?
- 2 Types
  - Average Speed (entire trip)

$$\bar{v} = \frac{\Delta s}{\Delta t}$$

  - Instantaneous Speed (speedometer reading)

$$v = \lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t}$$

Example 2

- During a road trip, a family travels for half an hour to the highway, 22 miles from their house. They travel 136 miles in 2 hours, stop for lunch for 1 hour and then reach their destination 3 hours and 201 miles later. What is the average speed during their trip?

Big Ideas

- Coordinate systems
  - Choose the most convenient for your problem
- Path length
  - Distance along an object's path
- Speed
  - Average speed
    - Entire path length / entire time for trip
  - Instantaneous Speed
    - Speedometer reading