



General Physics I

Math Warm-Up (Appendix A)
Measurements & Units

Coordinates & Speed (Ch 1, Secs 1-2)



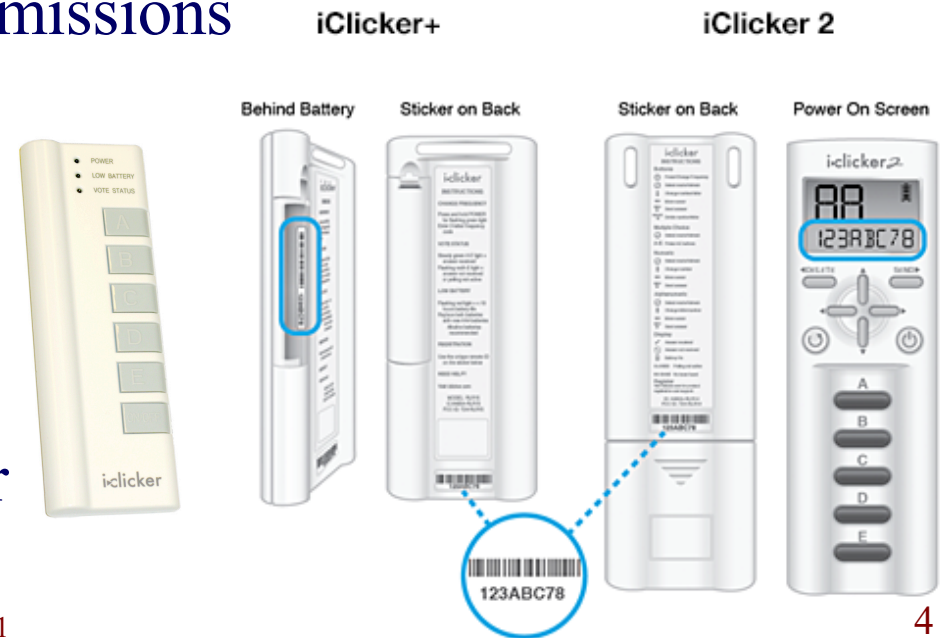
Day 1, Video 1

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



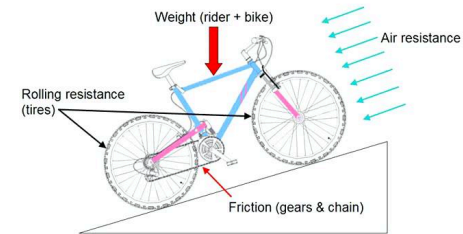
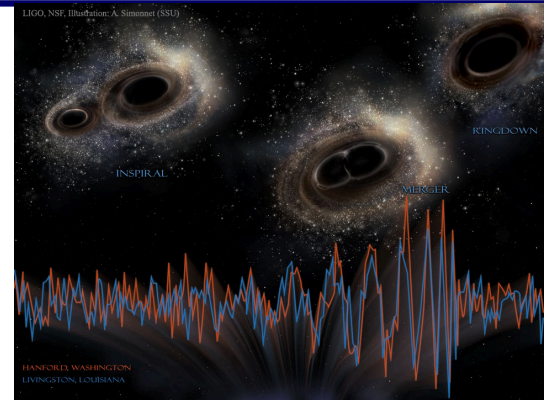
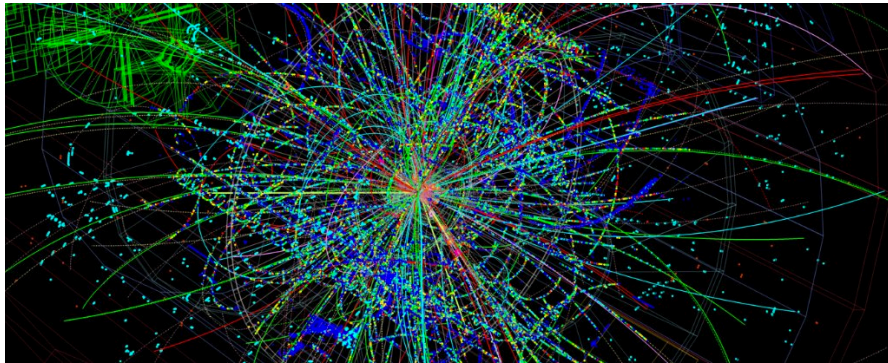
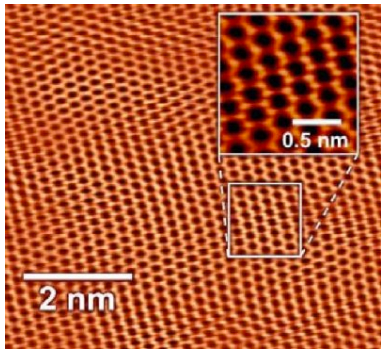
Question #1

- 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

$$10^0 = 1$$

$$10^{-1} = 0.1$$

$$10^1 = 10$$

$$10^{-2} = 0.01$$

$$10^2 = 100$$

$$3 \times 10^2 = 300.$$

Decimal moves to right

$$6 \times 10^{-2} = 0.06$$

Decimal moves to left

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

$$\frac{6 \times 10^6}{3 \times 10^4} = \frac{6}{3} \times 10^{6-4} = 2 \times 10^2$$



Algebra

- Natural exponents / logarithms

$$4 = e^x \quad \longleftarrow \text{Undo with } \ln$$

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

$$1.39 = x$$

$$\ln x = 3 \quad \longleftarrow \text{Undo with } e$$

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

$$x = 20.1$$



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

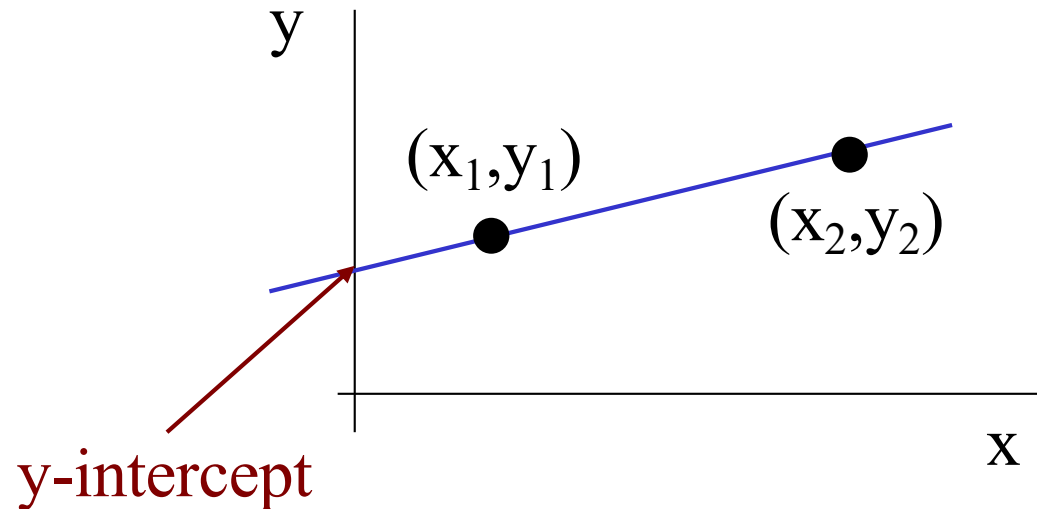


Linear Equations

$$y = mx + b$$

↑ ↑
slope y-intercept

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

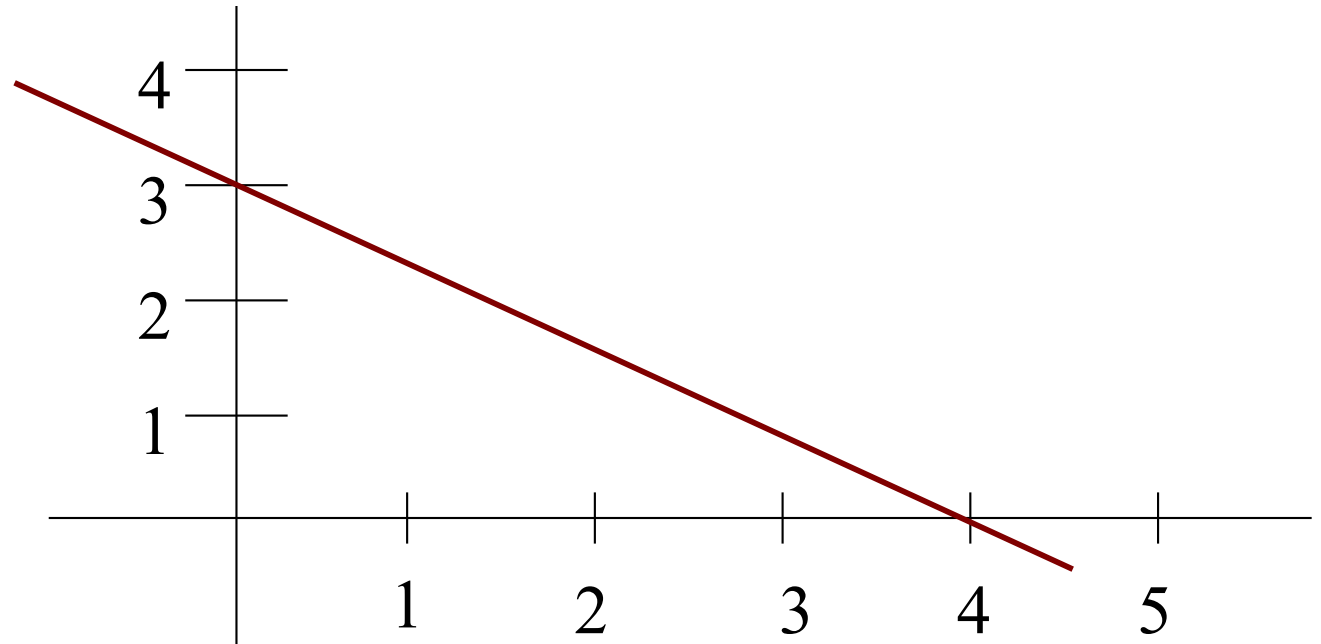




Question #3

- 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

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

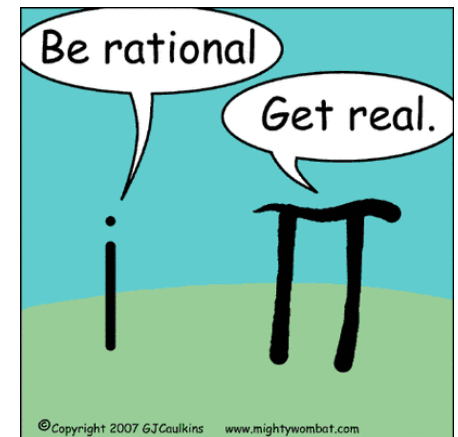
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Example:

$$\begin{array}{cccc} 4x^2 + 10x + 1 = 0 \\ \uparrow \quad \quad \uparrow \quad \quad \uparrow \\ a \quad \quad b \quad \quad c \end{array}$$

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

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



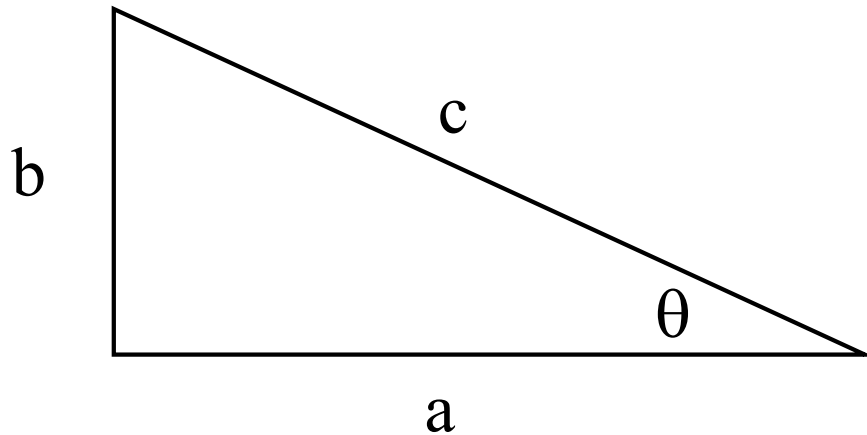


Question #4

- 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



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

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

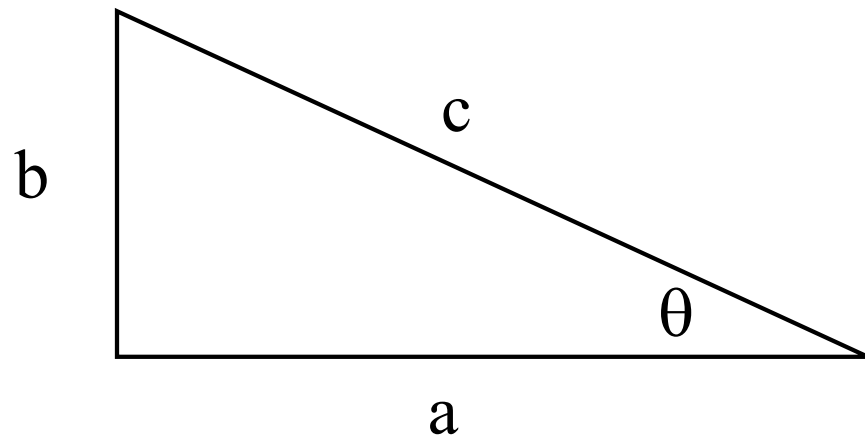
$$\tan \theta = \frac{b}{a} = \frac{\text{opposite}}{\text{adjacent}}$$

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



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

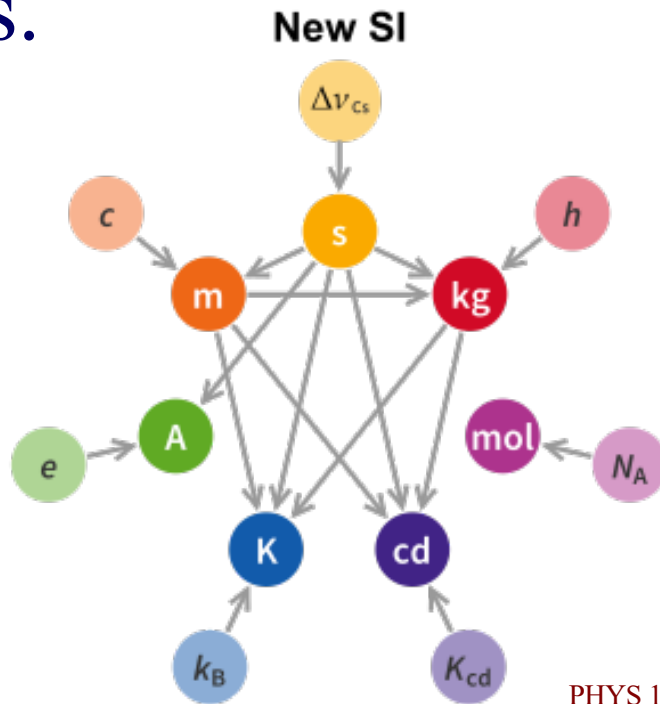
- Physical quantities (volume, distance, speed, etc.) expressed in units
- All units can be expressed in terms of the **fundamental units**
 - Area = Length², Speed = Length / Time





The New SI

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



Monday

PHYS 141

ALL CHANGE

Under the revised SI system, every unit will be defined in relation to a constant, whose value will become fixed. Many of the units will be defined in relation to each other: for example, definition of the kilogram requires Planck's constant, and definitions of the second and metre.

→ Dependency

SECOND (s)

Measures: Time
Requires: Hyperfine-transition frequency of the caesium-133 atom
Definition: Duration of 9,192,631,770 cycles of the radiation corresponding to the transition between two hyperfine levels of caesium-133

METRE (m)

Measures: Length
Requires: Speed of light
Definition: Length of the path travelled by light in a vacuum in $1/299,792,458$ seconds

KILOGRAM (kg)

Measures: Mass
Requires: Planck's constant
Definition: One kilogram is Planck's constant divided by $6.626\,070\,15 \times 10^{-34} \text{ m}^2\text{s}^{-2}$

AMPERE (A)

Measures: Current
Requires: Charge on the electron
Definition: Electric current corresponding to the flow of $1/(1.602\,176\,634 \times 10^{-19})$ elementary charges per second

MOLE (mol)

Measures: Amount of substance
Requires: Avogadro's constant
Definition: Amount of substance of a system that contains $6.022\,140\,76 \times 10^{23}$ specified elementary entities

KELVIN (K)

Measures: Temperature
Requires: Boltzmann's constant
Definition: Equal to a change in thermal energy of $1.380\,649 \times 10^{-23}$ joules

CANDELA (cd)

Measures: Luminous intensity
Requires: Luminous efficacy of monochromatic light of frequency 540×10^{12} Hz
Definition: Luminous intensity of a light source with frequency 540×10^{12} Hz and a radiant intensity of 1/683 watts per steradian

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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 = $1 \times 10^{-2} = 0.01$ meters

3 kilometers = $3 \times 10^3 = 3000$ 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!

$$\frac{0.20 \text{ glasses}}{\text{second}} \left(\frac{2 \text{ cups}}{1 \text{ glass}} \right) \left(\frac{1 \text{ gallon}}{16 \text{ cups}} \right) \left(\frac{231 \text{ in}^3}{1 \text{ gallon}} \right) \left(\frac{2.54 \text{ cm}}{1 \text{ in}} \right)^3 \left(\frac{60 \text{ seconds}}{1 \text{ min}} \right) = 5.7 \times 10^3 \text{ cm}^3 / \text{min}$$



Question #6

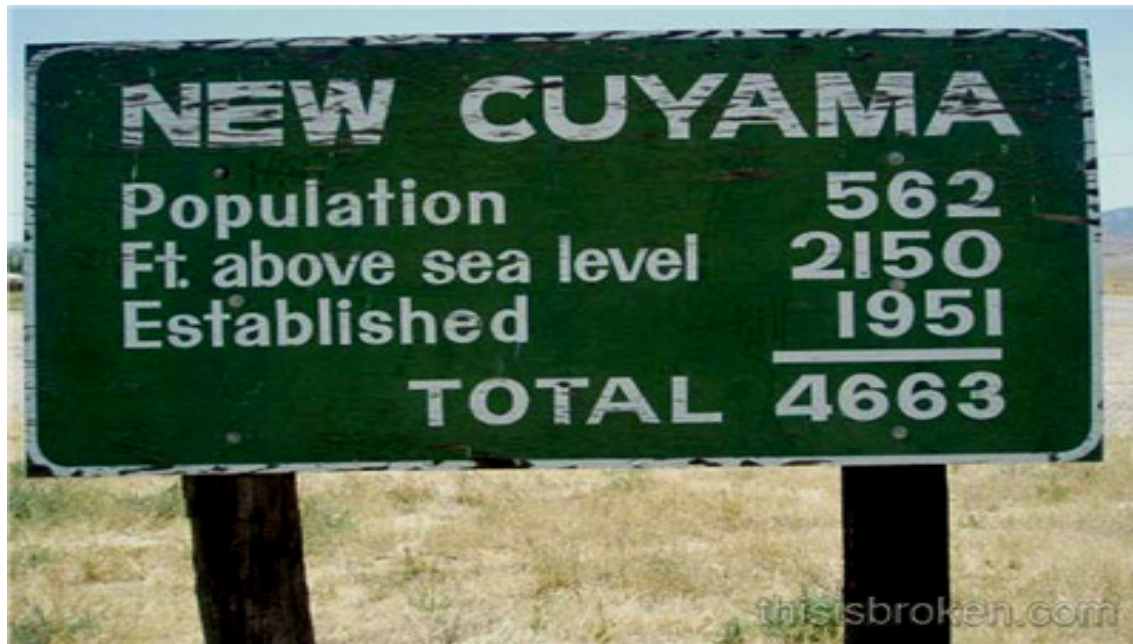
- A camel can drink 20 gallons of water at a time. Suppose you have 600 liters of water. How much water is this in camels? (Hint: 1 gallon = 3.786 liters)
- A. 2.45
B. 7.92
C. 10.0
D. 80.5





Tools of Physics – Dimensional Analysis

- It is important that units agree





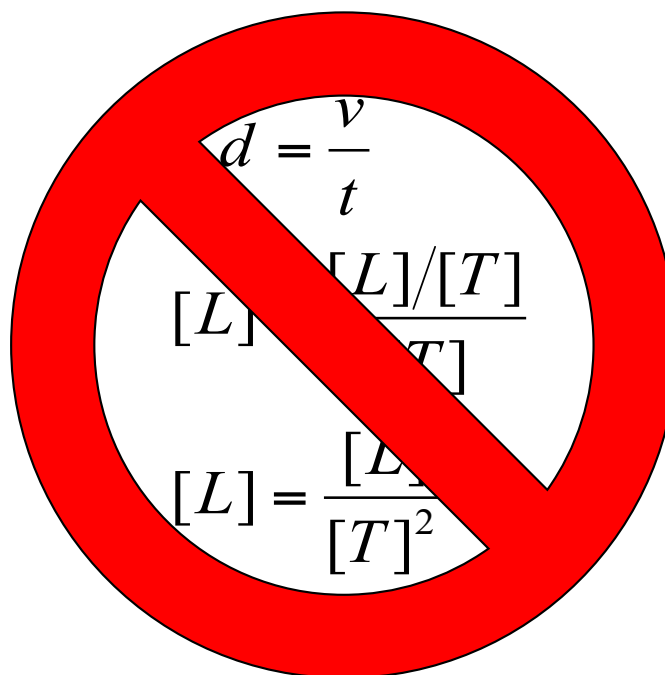
Tools of Physics – Dimensional Analysis

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

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

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

$$[L] = [L]$$





Question #7

- Which of the following could be correct?
 - A. $v = v_0 + at^2$ ($v = \text{velocity}$, $a = \text{acceleration}$)
 - B. $V = Ah$ ($V = \text{volume}$, $A = \text{area}$, $h = \text{height}$)
 - C. $ma = v^2$ ($m = \text{mass}$, $a = \text{acceleration}$, $v = \text{velocity}$)
- 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

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

$$(0.012)(1.630 \times 10^3) = 2.0 \times 10^1$$



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

120 (2 sig figs)
120.0 (4 sig figs)
120. (3 sig figs)
 1.20×10^2 (3 sig figs)

Right

0.12 (2 sig figs)
0.012 (2 sig figs)
0.120 (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



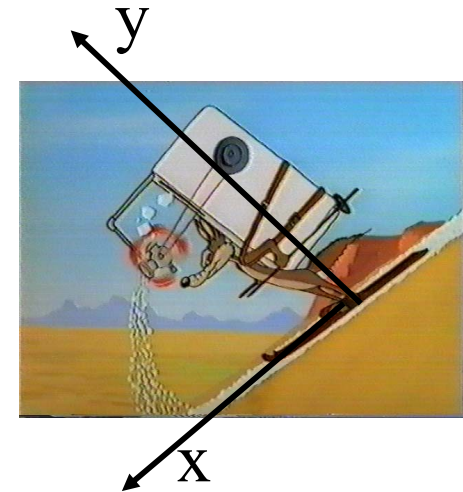
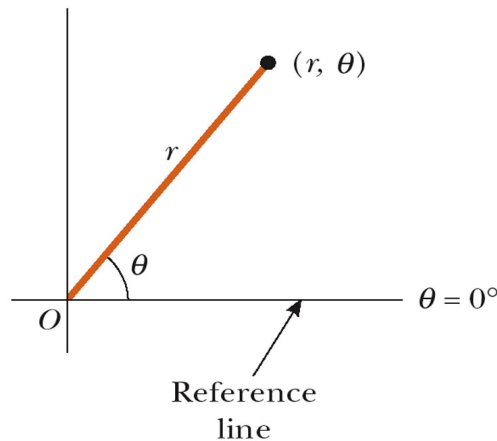
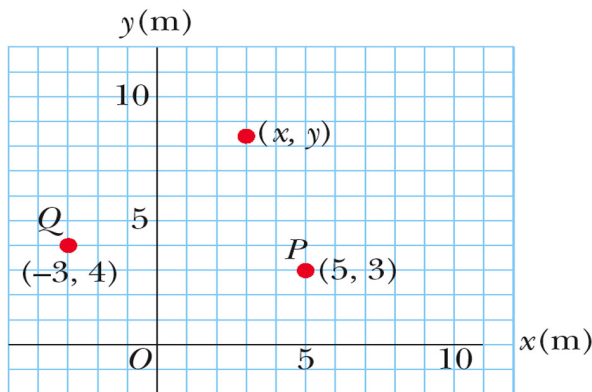
Day 1, Video 6

Coordinate Systems, Path Length & Speed



Tools of Physics – Coordinate Systems

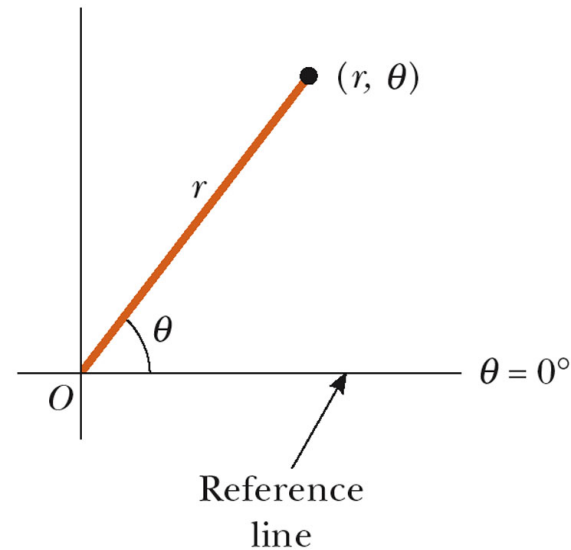
- Directions and positions of events & objects specified by **coordinate systems**
 - Origin plus coordinates / axes
- Choice of coordinate system up to the problem solver – choose a system that simplifies your problem





Example 1

- A point in radial coordinates is $r = 5$ cm and $\theta = 32^\circ$. What are the x and y coordinates of this point?

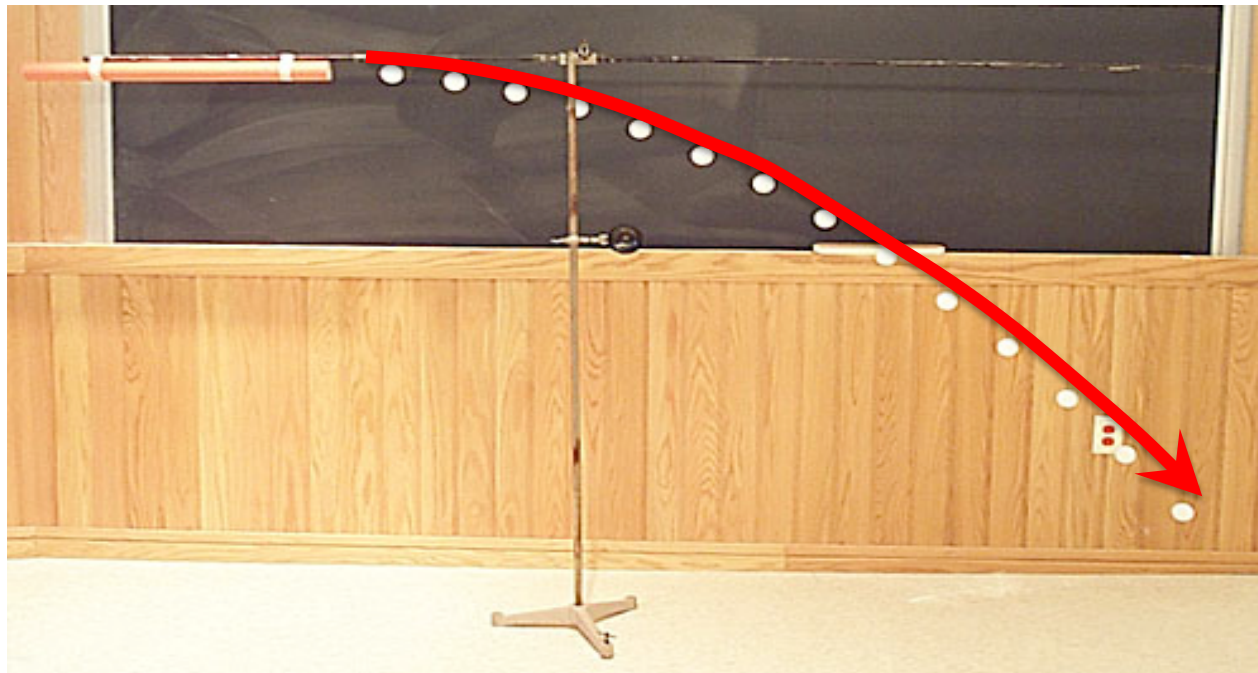


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Path Length

- 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)



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



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