INFO SHEET FOR AP PHYSICS 1

Room: 318
Teacher: L. Henry

Textbook: Knight. *College Physics: A Strategic Approach*: Pearson Education.

Course Description:
The goal of AP Physics 1 is to provide students with the scientific principles, concepts and methodologies required to better understand the physical world. This course is the first part of what was previously called AP Physics B. This course is designed to cover all topics covered in a typical introductory college algebra based physics course.

Big Ideas:
This course will cover the 6 big ideas outlined by the College Board.

1. Objects and systems have properties such as mass and charge. Systems may have internal structure.
2. Fields existing in space can be used to explain interactions
3. The interactions of an object with other objects can be described by forces.
4. Interactions between systems can result in changes in those systems.
5. Changes that occur as a result of interactions are constrained by conservation laws.
6. Waves can transfer energy and momentum from one location to another without permanent transfer of mass serve as a mathematical model for the description of other phenomena.

Class Days
Students will spend 75% of their time in the classroom participating in lecture, practice and assessment. Students are expected to arrive to class prepared and on time. Students are expected to do work outside of class, and are expected to have all homework completed when they enter class. No late homework will be accepted.

Lab Days
Students will spend one class period out of every four participating in college level physics labs. During these labs all seven of the science practices and most fundamental physics concepts will be addressed. Students will also be required to complete a minimum of seven inquiry labs that will require that the student writes the procedure as well as collecting data and completing any relevant calculations and conclusions. Labs will be assessed by a lab report, quiz or examination of the bound lab notebook. Lab concepts will also be addressed on the unit assessment.
Students will be required to keep a lab notebook that may be checked at any time during the year. This notebook will hold all labs completed throughout the year. Students must include predictions, procedures, data, data analysis and conclusions for each lab.

I. General Notes

1. All of my science students will be required to maintain a notebook as well as a lab notebook.
2. At the first sign of misunderstanding concerning a topic, you need to plan to stay after for help.
3. This class will include a trip to Six Flags, but I reserve the right to determine whether a student has met requirements to attend the trip.

AP Physics Summer Assignment

Read all information carefully and complete all problems. You must show your work for the problems to receive credit. Work may be shown on a separate sheet of paper if necessary.

Greek Letters

In Physics, we use variables to denote a variety of unknowns and concepts. Many of these variables are letters of the Greek alphabet. If you are not familiar with these letters, you should become so. While there is no practice work for this section and while you do not have to outright memorize these letters at this point, you need to have this exposure so that when class starts and you see this on the board: μ you don't call it, "that funny-looking m-thing".

These variables have specific names and I will be using these names. You need to do this as well.

Greek Letter	Name	Commonly used for
	Alpha (lowercase)	Angular acceleration, radiation particle
	Beta (lowercase)	Radiation particle
	Delta (uppercase)	Showing a change in a quantity
	Epsilon (lowercase)	Permittivity
	Phi (lowercase)	Magnetic Flux, work function
	Gamma (lowercase)	Radioactivity, relativity
	Lambda (lowercase)	Wavelength
	Mu (lowercase)	coefficient of friction
	Pi (lowercase)	Mathematical constant
	Theta (lowercase)	Angle name
	Rho (lowercase)	Density, resistivity
	Sigma (uppercase)	Showing the sum of numbers
	Tau (lowercase)	Torque
	Omega (lowercase)	Angular velocity
	Xi (uppercase)	Electromotive force; induced voltage

The Metric System

Everything in physics is measured in the metric system. The only time that you will see English units is when you convert them to metric units. The metric system is also called SI (from the French, "Système International"). In the SI system fundamental quantities are measured in meters, kilograms, and seconds.

Here are the metric prefixes that we will use throughout the year:

Name of prefix	Numerical value	Abbreviation
	10^{-12}	p
	10^{-9}	n
	10^{-6}	μ
	10^{-3}	m
	10^{-2}	c
	10^{3}	k
	10^{6}	M
	10^{9}	G

*Adapted from onwravens.net

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Note that the symbol for micro- is the lowercase Greek letter mu. Its name is "mu" (pronounced "me-you") and not, "that funny-looking m-thing".

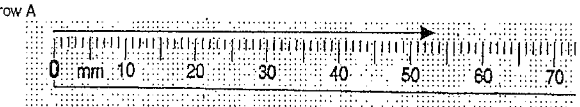
To help memorize some of these prefixes: micro- is the same prefix used in the word, "microscope" which is a tool used to view very small things. Mega- and micro- both start with the letter "m" and stand for, respectively, "million" and "millionth.

I. Measurements and Significant Figures

When using a measuring device, you **MUST** estimate between the smallest marks on the instrument. For example, if a ruler is marked off in increments of whole millimeters, you estimate the length of an object to the closest tenth of a millimeter.

Use the ruler below to measure the length of the arrow. Remember to estimate between the smallest marks.

Arrow A



The length of the arrow is __________ mm.

Precision is also important in labs and when solving problems. In Physics, the same thing is true—you can not round numbers at will. You must obey the rules for significant figures.

	example	# of sig.figs.
Non - zero numbers are significant.	126 245 g	6
Zeros between non - zero numbers are significant.	12 027 m	5
Zeros at the end of the number to the right of the decimal are significant.	23.00 kg	4
Zeros in front of non zero numbers are not signifcant.	0.0502 s	3
Zeros at the end of the number to the left of the decimal are not significant unless they were measured. Use scientific notation for clarity.	1000 m 1.00×10^3 m	unknown, could be 1 to 4 3, zeros would not be shown unless they were measured.

When adding or subtracting numbers, the precision of the answer can be no greater than the precision of the least precise value.

```
   9 7 . 3        (least precise value, your answer will be rounded to the same
                   decimal place as this value)
       4 . 3 2
+      0 . 1 4 7
 1 0 1 . 7 6 7    → round to nearest 1/10th so final answer is 101.8
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97.3 is only known to the nearest 1/10th, 4.32 to the nearest 1/100th, and 0.147 to the nearest 1/1000th. Therefore the final answer must be rounded to the nearest 1/10th.

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When multiplying or dividing numbers, the final answer has the same number of significant figures as the measurement having the smallest number of significant figures.

9.81	3 significant figures
x 0.0053	2 significant figures
0.051993	round to 2 significant figures → 0.052

In laboratory work, values calculated from measurements cannot be more precise than the measurements themselves. For example, if we measure the sides of a cube to be 0.252 m, 0.253 m, and 0.251 m, when the volume is determined we use significant figure rules.

0.252 x 0.253 x 0.251 = 0.016002756 in a calculator.

However, we can only keep three significant figures, so you would record 0.0160 m^3.

Note that significant figures rules are a guideline to determine precision of calculations. The actual experimental conditions and procedures may result in precision that is worse than what significant figures rules allow. But the precision of calculations based on one-time measurements cannot be better than what the significant figures rules allow.

In Physics, we often use the slope of a best-fit line to average together the results of many measurements.

Problems:

1. Two students are measuring the density of a block of wood. The measurements of the block are length = 0.240 m, width = 0.152 m and height = 0.205 m. The mass is measured to be 4.253 kilograms. Calculate the density to the correct number of significant digits. (Recall that density is mass divided by volume.) How could this experiment be improved using the slope of a graph? What would you graph?

2. To determine the average velocity of a bowling ball, students measure the distance traveled as 15.00 meters, and the time as 10.35 seconds. Calculate the average velocity to the correct number of significant figures. (Recall that velocity is displacement divided by time.) Considering human reaction time, do you think significant figures rules give a valid estimation of the precision of the experiment? Explain. How could this experiment be improved using the slope of a graph? What would you graph?

Vectors

Please view the Force + vector powerpoint and work the 10 problems on the next page.

VECTOR ADDITION

☞ Sketch a diagram for each problem, then solve it.

1. Two people are pushing a disabled car. One exerts a force of 200 N east, the other a force of 150 N east. What is the net force exerted on the car? (Assume friction to be negligible.)
2. Two soccer players kick a ball simultaneously from opposite sides. Red #3 kicks with 50 N of force while Blue #5 kicks with 63 N of force. What is the net force on the ball?
3. An airplane flies due north at 100 m/s through a 30 m/s cross wind blowing from the east to the west. Determine the resultant velocity of the airplane.
4. A mountain climbing expedition establishes a base camp and two intermediate camps, A and B. Camp A is 11,200 m east of and 3200 m above base camp. Camp B is 8400 m east of and 1700 m higher than Camp A. Determine the displacement between base camp and Camp B.
5. A plane flies with a velocity of 52 m/s east through a 12 m/s cross wind blowing the plane south. Find the magnitude and direction (relative to due east) of the resultant velocity at which it travels.
6. An ambitious hiker walks 25 km west and then 35 km south in a day. Find the magnitude and direction (relative to due west) of her resultant displacement.
7. A boat heads directly across a river with a velocity of 12 m/s. If the river flows at 6.0 m/s find the magnitude and direction (with respect to the shore) of the boat's resultant velocity.
8. I went for a walk the other day. I went four avenues east (0.80 miles), then twenty-four streets south (1.20 miles), then one avenue west (0.20 miles), and finally eight streets north (0.40 miles).
   a. What distance did I travel?
   b. What's my resultant displacement?
9. A plane intends to fly north with a speed of 250 m/s relative to the ground through a high altitude cross wind of 50 m/s coming from the east. Determine ...
   a. the bearing that the plane should take (relative to due north) and
   b. the plane's speed with respect to the air.
10. At a particular instant, a stationary observer on the ground sees a package falling from a moving airplane with a speed v_{observer} at an angle θ to the vertical. To the pilot flying horizontally at a constant speed relative to the ground the package appears to be falling vertically with a speed v_{pilot} at that same instant. What is the speed of the pilot relative to the ground in terms of the given quantities?

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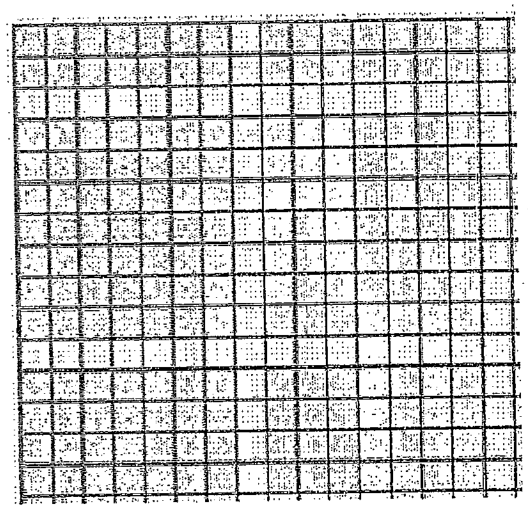
Graphing and Graph Interpretation

You should be familiar with graph construction (by hand and on a calculator). This is a topic that often appears on AP exams and is an easy way to score points on any assignment.

Note: When you are told to graph Apples vs. Oranges, the first thing goes on the y-axis. The second thing is on the x-axis.

Fill in the following table and plot the points on the grid below as distance versus time. Be sure to correctly label the graph (axes labels, including units, and title)

Time, *t* (s)	Distance, *d* (m)
0.0	0 m
1.0	5.1 m
2.0	9.9 m
3.0	15.2 m



Draw the best fit line through your data points. Use a graphing calculator to plot the graph. Record the equation of the best-fit line. What is the slope of the line that you plotted (with correct units)?

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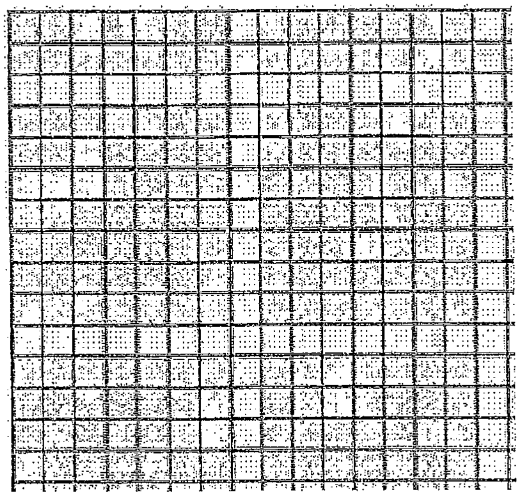
Plot position vs. time on the axes below.

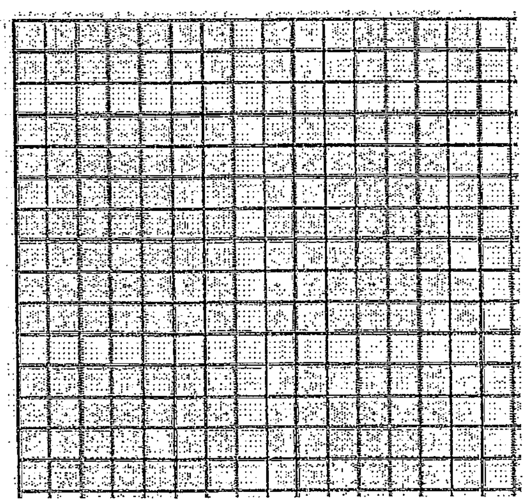
Time	Position
0.0 s	0.0 m
1.0 s	4.1 m
2.0 s	15.8 m
3.0 s	36.2 m



On your graphing calculator, create this plot and find the equation of the best fit curve. Record this best-fit equation below.

This graph has a changing slope. What does its slope represent?

This quadratic function can be "linearized" by squaring the time values, and plotting position vs. time squared. Try this with this data.



Find the equation of this best fit line on your graphing calculator. Record the equation of this best fit curve below.

Find the slope of this graph (use correct units). What does it represent?

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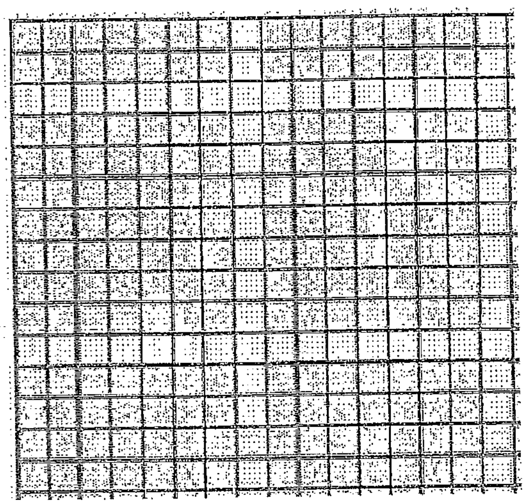
Other function types.

The results of a class experiment investigating the relationship between mass and acceleration are shown in the table below. The force applied to each mass was the same.

Mass (kg)	Acceleration (m/s^2)
1.0	6.00
2.0	3.00
3.0	2.00
4.0	1.50
4.8	1.25
6.0	1.00



a. Plot the values given and draw the curve that best fits the points.

b. What is the relationship between mass and acceleration produced by a constant force (describe the plot you created in a.)?

c. What can you say about the relationship between the values for mass and those for acceleration? Use a graphing calculator to find the equation of the best-fit curve to your data. Record it below.

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Algebra & Functions

A working knowledge of algebra is essential to success in physics. In AP Physics, there is more symbolic algebra, where symbols are used exclusively (no numbers!).

A **direct proportion** is a function whose graph is a non-horizontal line that passes through the origin. **y = kx ; k is the constant of proportionality**

A **linear** function has a graph that is a non-horizontal line. **y = mx + b; m is the slope of the line and b is the y-intercept.** A direct proportion is a special case of a linear function, where b = 0.

A **quadratic** function has a graph that is a parabola. When y is proportional to x^2, the graph goes through the origin and has a slope that increases as x increases. **$y = ax^2 + bx + c$**

An **inverse** relation has a graph that is a hyperbola (in the first quadrant). When y is proportional to 1/x, the graph is asymptotic to the x and y axes. **y = k/x**

Identify the variable relationships.

1. *F = -kx, (F vs. x) This function is _________________________________. K represents the ___________________________ of the graph.*
2. *U = mgh, (U vs. h) This function is _________________________________. mg represents the ___________________________ of the graph*
3. *$x = \frac{1}{2}at^2$ (x vs. t) This function is _________________________________. Its graph will look like ____. If x is graphed vs. t^2 the slope will be _________________________.*
4. *a=F/m (a vs. m). This function is ___________________________________. Its graph will look like ____.*

Solve the following. Show work for credit:

5. Solve for d_i $\quad \frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$
6. Solve for a. $\quad y = v_o t - \frac{1}{2}at^2$
7. Solve for θ_2 $\quad n_1 \sin\theta_1 = n_2 \sin\theta_2$
8. Solve for L $\quad T = 2\pi\sqrt{\frac{L}{g}}$
9. Solve for V_2 $\quad \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

AP® PHYSICS 1 EQUATIONS

MECHANICS

$v_x = v_{x0} + a_x t$

$x = x_0 + v_{x0} t + \frac{1}{2} a_x t^2$

$v_x^2 = v_{x0}^2 + 2a_x (x - x_0)$

$\vec{a} = \frac{\sum \vec{F}}{m} = \frac{\vec{F}_{net}}{m}$

$|\vec{F}_f| \le \mu |\vec{F}_n|$

$a_c = \frac{v^2}{r}$

$\vec{p} = m\vec{v}$

$\Delta \vec{p} = \vec{F} \Delta t$

$K = \frac{1}{2} m v^2$

$\Delta E = W = F_{\parallel} d = F d \cos\theta$

$P = \frac{\Delta E}{\Delta t}$

$\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$

$\omega = \omega_0 + \alpha t$

$x = A\cos(2\pi f t)$

$\vec{\alpha} = \frac{\sum \vec{\tau}}{I} = \frac{\vec{\tau}_{net}}{I}$

$\tau = r_\perp F = r F \sin\theta$

$L = I\omega$

$\Delta L = \tau \Delta t$

$K = \frac{1}{2} I \omega^2$

$|\vec{F}_s| = k|\vec{x}|$

$U_s = \frac{1}{2} k x^2$

$\rho = \frac{m}{V}$

a	=	acceleration
A	=	amplitude
d	=	distance
E	=	energy
f	=	frequency
F	=	force
I	=	rotational inertia
K	=	kinetic energy
k	=	spring constant
L	=	angular momentum
ℓ	=	length
m	=	mass
P	=	power
p	=	momentum
r	=	radius or separation
T	=	period
t	=	time
U	=	potential energy
V	=	volume
v	=	speed
W	=	work done on a system
x	=	position
y	=	height
α	=	angular acceleration
μ	=	coefficient of friction
θ	=	angle
ρ	=	density
τ	=	torque
ω	=	angular speed

$\Delta U_g = mg\Delta y$

$T = \frac{2\pi}{\omega} = \frac{1}{f}$

$T_s = 2\pi\sqrt{\frac{m}{k}}$

$T_p = 2\pi\sqrt{\frac{\ell}{g}}$

$|\vec{F}_g| = G\frac{m_1 m_2}{r^2}$

$\vec{g} = \frac{\vec{F}_g}{m}$

$U_G = -\frac{G m_1 m_2}{r}$

ELECTRICITY

$|\vec{F}_E| = k\left|\frac{q_1 q_2}{r^2}\right|$

$I = \frac{\Delta q}{\Delta t}$

$R = \frac{\rho \ell}{A}$

$I = \frac{\Delta V}{R}$

$P = I \Delta V$

$R_s = \sum_i R_i$

$\frac{1}{R_p} = \sum_i \frac{1}{R_i}$

A	=	area
F	=	force
I	=	current
ℓ	=	length
P	=	power
q	=	charge
R	=	resistance
r	=	separation
t	=	time
V	=	electric potential
ρ	=	resistivity

WAVES

$\lambda = \frac{v}{f}$

f	=	frequency
v	=	speed
λ	=	wavelength

GEOMETRY AND TRIGONOMETRY

Rectangle
$A = bh$

Triangle
$A = \frac{1}{2} bh$

Circle
$A = \pi r^2$
$C = 2\pi r$

Rectangular solid
$V = \ell w h$

Cylinder
$V = \pi r^2 \ell$
$S = 2\pi r \ell + 2\pi r^2$

Sphere
$V = \frac{4}{3}\pi r^3$
$S = 4\pi r^2$

A	=	area
C	=	circumference
V	=	volume
S	=	surface area
b	=	base
h	=	height
ℓ	=	length
w	=	width
r	=	radius

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

$\sin\theta = \frac{a}{c}$

$\cos\theta = \frac{b}{c}$

$\tan\theta = \frac{a}{b}$