AP Physics 1

Summer Introductory Packet 2018

Mrs. Neary

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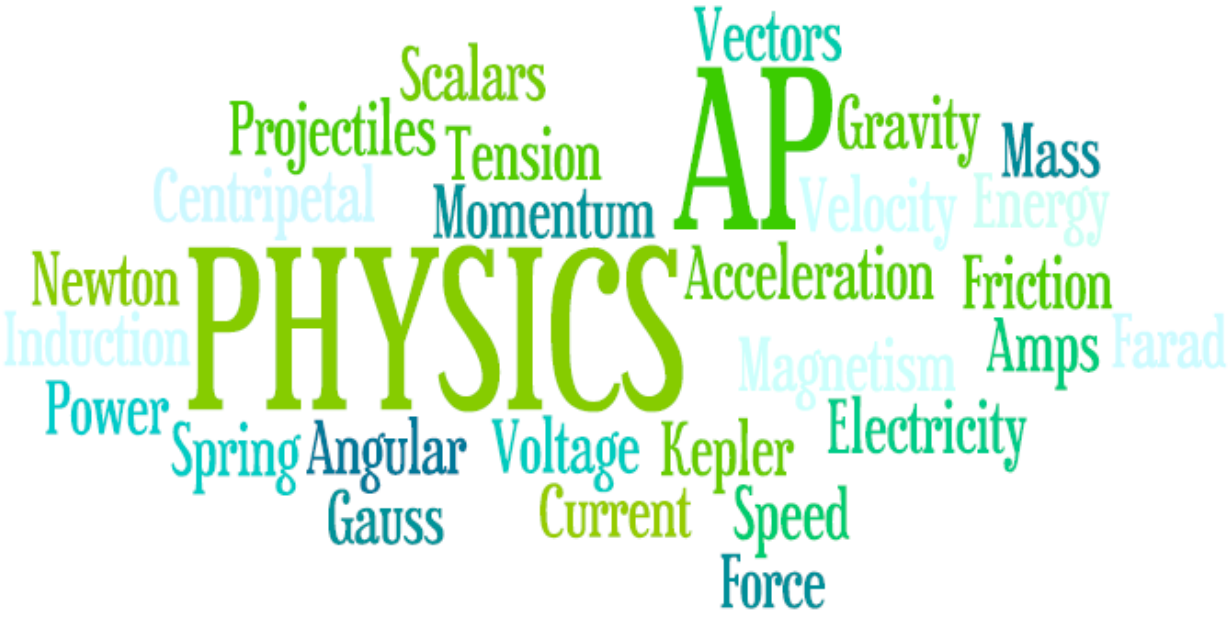


Name: _____

Welcome to AP Physics 1!

I am so happy you have decided to join this class. You can count yourself among the 5% of elite US high school students who chose to challenge themselves with a rigorous AP physics class. Congratulations! *Please feel free to contact me with any questions throughout the summer at* patricia_neary@hcpss.org I can also e-mail you a copy of this study guide.

Summer Packet

This packet is intended to serve as a review for some algebra and trigonometric concepts you have learned in previous classes. Physics is NOT a math class. But you can't do college-level physics without math. Therefore, you need to be solid in the basic math techniques that we use frequently in AP Physics (Don't worry, we'll review these in Sept!). However, taking the time to review these concepts over the summer will only help you in the fall! *On the 1st day back if you show me any AP Physics 1 work you did over the summer, you will earn extra credit on your first unit test!*

AP Physics 1 Course Content

This course is equivalent to a one-semester, algebra based, college-level physics course, especially appropriate for students planning to specialize or major in any science, medical or engineering field. The course explores the topics listed below.

1) Kinematics in One & Two Dimensions
2) Circular Motion & Universal Gravitation
3) Dynamics – Newton's Laws
4) Impulse, Momentum & Conservation of Momentum
5) Energy & Conservation of Energy
6) Rotational Motion & Conservation of Angular Motion
7) Mechanical Waves & Sound
8) Simple Harmonic Motion
9) Electrostatics
10) DC Circuits

A few words about the final assessment

It is highly recommended and encouraged that you take the AP Physics 1 exam. Even if you plan on taking 1st year physics at college you may still be able to use the course as 3 credits toward an elective science, depending on your major. This will ease your credit load 1st semester, as you begin your collegial journey. Financial assistance may be available to you to cover the cost of the AP exam, please see your counselor to discuss this.

Resources:

The Ultimate Guide to the AP Physics 1 Exam: https://blog.collegevine.com/ultimate-guide-to-the-ap-physics-1-exam/
An app for AP Practice Questions http://appcrawlr.com/ios/ap-exam-prep-calculus-ab-bc-che%2523authors-description
AP Physics 1 Exam Prep Guide http://www.physicscoach.com/ap05types.pdf

AP Exam Overview

Next year's exam is Tuesday, May 7, 2019. The AP 1 exam consists of 2 sections:

Section I: Multiple Choice | 50 Questions | 90 Minutes | 50% of Exam Score

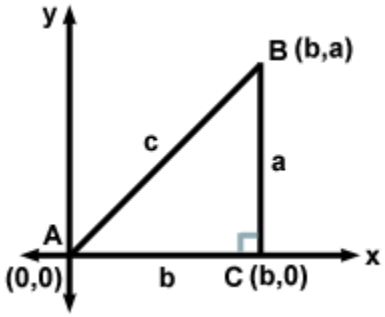
Section II: Free Response | 5 Questions | 90 Minutes | 50% of Exam Score

- 1 Experimental Design
- 1 Qualitative/Quantitative Translation
- 3 Short Answer (1 requiring a paragraph length argument)

Enjoy your Summer!

Geometry/ Trig Review

Consider the right triangle pictured below:



Using the lengths of the sides of right triangles such as the one above, the trigonometric functions can be defined in the following way:

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

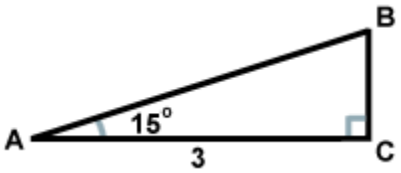
$$\sin(A) = \frac{\text{opposite side}}{\text{hypotenuse}} = \frac{a}{c}$$

$$\cos(A) = \frac{\text{adjacent side}}{\text{hypotenuse}} = \frac{b}{c}$$

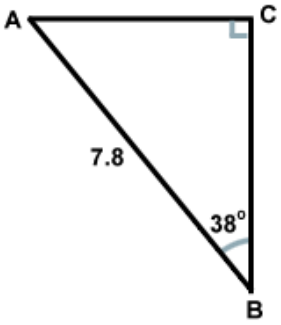
$$\tan(A) = \frac{\text{opposite side}}{\text{adjacent side}} = \frac{a}{b}$$

Find the other lengths of these triangles using the trig functions and/or the Pythagorean theorem. Show your work on a separate sheet of paper:

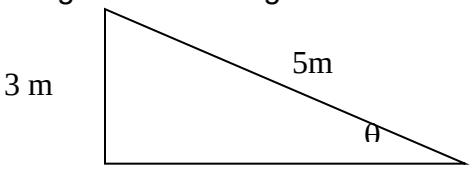
1.



2.

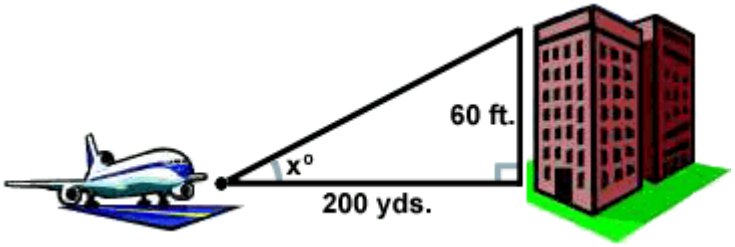


If you need to find an angle, you can use ArcSin ($\sin^{-1}$), ArcCos and ArcTan. For instance, if you are given this triangle:



Solve the angle, □. You know that sin □ = 3/5, so in your calculator type:
2nd sin which looks like $\sin^{-1}$ (3/5) enter. This will give you 36.87 degrees. You can do the same with Cos and Tan.

3. An airplane takes off 200 yards in front of a 60 foot building. At what angle of elevation must the plane take off in order to avoid crashing into the building? Assume that the airplane flies in a straight line and the angle of elevation remains constant until the airplane flies over the building.



Density Review

Population density is the number of people per unit area. In physics, density functions are often used for charge densities, mass densities and current densities. Density is a measure of stuff per unit space. The one you are most familiar with is mass density is mass/volume. You can also have one and two dimensional densities.

Linear mass density $\lambda = \frac{m}{l}$ (mass/length)

Surface mass density $\sigma = \frac{m}{A}$ (mass/ area)

Volume mass density $\rho = \frac{m}{V}$ (mass/volume)

You can also replace the mass (m) with charge (q) to determine charge densities or current (I) to determine current densities. So volume charge density is the charge per unit volume.

Volume of a sphere: $\frac{4}{3}\pi r^3$

Surface area of a sphere: $4\pi r^2$

Volume of a cylinder= $\pi r^2 h$

Surface area of a cylinder: $2\pi rh$ (for the sides) + $2\pi r^2$ (for the ends)

4. An iron sphere has a mass density of $\rho = 7.86 \times 10^3$ kg/m^3. If the sphere has a radius of .5 m, how much mass does the sphere contain?

5. A sphere made out of material x has a mass of 5 kg and has a radius of 4m. How much mass does a sphere of the same material with a 3 m radius have? (hint: since they are the same material, they have the same density)

6. A sphere made out of material y has a mass of 6 kg and has a radius of 3m. How much mass does a cylinder of the same material with a 4 m radius and a 2 m length have?

Unit Conversions

In physics, we have common units in which we measure variables. For example, velocity (v) is measured in meters per second (m/s). Mass (m) is in kilograms (kg). I hope that you all have been comfortable going from one unit to another in chemistry and math. We'll need to do this, as well as understand "dimensional analysis." Keep in mind that units just multiply and divide algebraically.

Factor	Prefix	Symbol
10^{9}	Giga	G
10^{6}	Mega	M
10^{3}	kilo	K
10^{-2}	centi	C
10^{-3}	milli	M
10^{-6}	Micro	□
10^{-9}	nano	N
10^{-12}	pico	p

1 meter = 39.37 inches
12 inches = 1 ft
1 pound = 4.448 newtons

The way that I advocate doing conversions is by setting up an algebraic equation. For instance, let's say that I want to convert 20 inches to nanometers.

$$20 inches\left(\frac{1 meter}{39.37 inches}\right)\left(\frac{1 nanometer}{10\text{^}-9 meters}\right) = 5.08 \text{ x } 10^{8} \text{ nanometers}$$

You can see that the inches on top and inches on the bottom cancel out, and so do the meters, leaving you with nanometers

7. How many centimeters are in 48 inches?

8. How many inches are in 28nm?

9. How many pounds are in 600 Newtons?

10. How many kilonewtons are in 3.07 pounds?

You should also know that sometimes we have a unit which is actually a substitution for many units. For example, we know that F = ma. (force = mass x acceleration).

From your first physics course, you know that the unit of force is measured in Newtons. But, from the equation, F= ma, we see that the units of force should be the mass unit (kg) multiplied by the acceleration unit (m/s^2)

That means that a Newton is actually equal to a kgm/s^2.

Now try figuring out these units.

11. A Joule is a measure of energy. What is a Joule equal to (in terms of kg, m, and s?) HINT: KE = ½ mv^2 and PE = mgh.

12. If momentum = mv, what is the unit of momentum?

13. Here's a harder one, in terms of Newtons (and other units like kg m,s) solve for what a Joule is.

Ratios

Many times, the relationships of numbers lets us understand what these equations mean. Lets say that we push a block of mass m with a force of F and it accelerates with a value of a.

14. If we push another block with mass 2m, how much force is needed to have the same acceleration, a?

15. What if we now push a block of mass 3m with a force of 2F. What will the acceleration be? (in terms of a, like 2a, 0.5a, etc)

16. KE = ½ mv^2. How much would the kinetic energy of an object change if it has 3 times the initial velocity?

Manipulating Formulas

Solve for the variable:

$v = \frac{x}{t}$ $t = \frac{x}{v}$ $x = vt$

$x = vt + x_o$ v = _____, t = _____, x_o = _____

$a = \frac{v}{t}$ v = _____, t = _____

$v = v_o + at$ v_o = _____, a = _____, t = _____

$a = \frac{\mathbf{F}}{m}$ **F** = _____, m = _____

a) Challenging Manipulations

$x = x_o + v_o t + \frac{1}{2} at^2$ x_o = _____,
v_o = _____,
a = _____,
t = _____ (quadratic formula)

$v^2 = v_o^2 + 2a(x - x_o)$ v = _____,
v_o = _____,
a = _____,
x = _____,
x_o = _____

Simultaneous Equations

Now let's look at some simultaneous equations (systems of equations). There are a few ways to solve these problems. Take a look at this example:
Solve for x and y:
5x -2y = 15
7x – 5y = 18

Solution 1 You can graph the equations by solving for y. y = 5x/2 -15/2 and
y = 7x/5 -18/5 and the solution is the point of their intersection. Try it out, you should get (3.54,1.36).

Solution 2 The way that you were first taught to solve systems of equations was probably to do substitution; solve one variable in terms of the other and then substitute it in. This is most useful for simple equations.

If you solve for y in the first equation, you will get y = $\frac{5x}{2} - \frac{15}{2}$

Then substituting in y for the second equation, you find x = 3.54
Then by substituting x in for any of the above equation, you can find y =1.36
Check your answer by substituting your answers into the other equation; it should solve both equations.

On a separate sheet of paper, solve these problems using **solution 2 and check your answer.**

17. 5x + y = 13
3x = 15 – 3y

18. 2x + 4y = 36
10y – 5x = 0

19. 2x – 4y = 12
3x = 21 + 6y

Solution 3: Another way to solve these systems of equations is to put them on top of each other and algebraically manipulate them. This is what we'll be doing most.

5x -2y = 15
7x – 5y = 18

Our goal is to cancel one variable out by performing some operation with the equations (addition, subtraction, multiplication and division). For instance, if we multiply the top equation by 5 and the bottom by 2, we can get the top and bottom equations to have the same y term.

1. Rearrange each equation so the variables are on one side (in the same order) and the constant is on the other side.
2. Multiply one or both equations by an integer so that one term has equal and opposite coefficients in the two equations.
3. Add/Subtract/Multiply/Divide the equations to produce a single equation with one variable.
4. Solve for the variable.
5. Substitute the variable back into one of the equations and solve for the other variable.
6. Check the solution--it should satisfy both equations.

5(5x -2y = 15)
2(7x – 5y = 18)

25x -10y = 75
14x -10 y = 36

Now let's subtract the two equations

25x -10y = 75
- (14x -10 y = 36)
---
11 x = 39
x = 39/11 = 3.54

Then substitute that in for one of the equations above and find y = 1.36

Solution 4 Finally, you can do this in your calculator! Here are directions for a Ti-83.

5x -2y = 15
7x – 5y = 18

You always want the x's to be along the same column and the y's to be along the same column.

First we'll make a matrix for the values of x and y.
Hit the "matrix" button, scroll to "edit," hit "enter"
For matrix [A], make it 2x2. Complete the table so that it looks like this
[5 -2]
[7 -5]

Next, we'll make a matrix with the solutions. Click "matrix", scroll to "edit", scroll down to [2:B] and hit "enter." Make it 2 X 1
[15]
[18]

Quit (2^{nd} Mode) to your blank screen.
Now type "matrix" enter for [A]
Then hit the x^{-1} button.
Then "matrix" and scroll down to [B]
Your calculator should look like $[A]^{-1}$ [B]. Hit enter.

It should display [3.54]
[1.36]

The first solution is x and the second is y. You can see that these are the answers we got above! Pretty cool, huh? Just remember, if you have an x term but not a y term, you need to plug in zero.

If you have an x, y and z term, you can make matrix [A] 3X3 and matrix [B] 3X1 and it will work just the same.

Mathematical Reasoning & Estimating

25. Let's say the Earth's crust has an average thickness of 30 km. If the Earth's radius is $6x10^6$ m, what is the volume of the crust? (hint: the answer is not $1.36x10^{19}$ cubic meters, although that's close)

26. How many tennis balls would fill your bedroom?

27. Make an intelligent estimate for the number of high school teachers in the US. Show your work. (US population is about 300 million)