Dr. Van Laningham - AP Physics 1 Summer Assignment - Summer 2020

Hello Future AP Physics Student,

Thank you for taking a look at your summer assignment! I hope you are looking forward to our class; this will be my second year teaching AP Physics, and I am excited to bring what I have learned over the course of this past year to our classroom.

The one item of school supplies that I am asking you to purchase and bring to our class this year is a **quad-ruled (graph paper) notebook, either composition or spiral**. Try to avoid the types with a glued spine which allows you to easily tear out pages; these tend to fall apart. You will also want a scientific calculator. Graphing calculators are fine, you just need something able to do trig functions. Please also get in the habit of bringing a charged Chromebook with you each day. I advise that you have both pencils and pens; you will use pencils for testing.

The best preparation that you can do over the summer is to ensure that your knowledge of algebra is good and your skill in using the tools of algebra remains sharpened. Physics, at our level, is the study of how objects in the universe move and interact. We use mathematical equations (i.e., formulas) to represent relationships between various physical properties. If you have to learn the math as we go, you will not have a good time!

Here are some math skills that should (ideally) be second nature for you when we start:

- Solving an equation for any particular variable, with or without substitution of terms
- Finding angles and side lengths of right triangles using SOH CAH TOA
- Solving basic systems of equations with substitution
- Estimating how changes to a particular variable affects others in an equation
- Drawing, labeling, and interpreting a graph using ordered pairs

If you do not feel comfortable with one or more of these skills, **your one and only summer assignment is to use your favorite online educational resource to "git gud"**. If you are unsure of a resource, would like to have more direction, or just want to ask a question, email me at gregg_van_laningham@dekalbschoolsga.org. I will try to check that account a couple of times a week throughout the summer. Please note that if you feel comfortable with your algebraic chops, simply enjoy your break! But don't say I didn't try to warn you. ;)

You might be asking yourself right now, "Well, what sorts of formulas are we talking about?" The AP Physics 1 formula sheet holds most of the equations we will discuss in class. You will always have access to it on every quiz and exam, including the AP Exam. I have added the front page of the formula sheet to the end of this document so that you can start to take a look at it. Don't panic! We will work to make sure that you have the opportunity to know what it all means and use it successfully.

To assist your planning and preparation, let's now walk through a basic physics problem. Generally speaking, physics problems give you partial information about a situation and ask you for other information which has not been directly given to you.

Our example: *A student holds a 3 kg ball 1.5 m above the ground. The student then lets go of the ball. Assuming no air resistance, how long will it take the ball to hit the ground?*

The process we will use in answering the question above is the same process we will use for every question this year. I will probably annoy you, early on, with my insistence that you show your work and not skip steps. I do this because you need to develop good habits with easy problems so that you are better prepared for more complex and challenging problems as the year progresses. When I was in high school, I didn't like it either. I've learned better.

The first step to solving this problem is to identify the information that has been given to us directly, the information that has been given to us indirectly, as well as the information that has been requested. For the above example, you will learn to write the following on your page:

Given: $m = 3$ kg, $y_0 = 1.5$ m, $v_0 = 0$ m/s
Find: Δt

The above would read aloud as, "Given: m equal to three kilograms, y-naught equal to one point five meters, v-naught equal to zero meters per second. Find: delta t" The m stands for mass, y_0 for initial height, v_0 for initial velocity. Note that the problem didn't tell us the initial velocity directly, but our reading of the problem allows us to know the ball began at rest. The triangle is a Greek uppercase delta and represents a change, because we're looking for the change in time between when the ball drops and when it hits the ground.

Reminder: I do not expect you to know all this yet, this is just an example of what we will learn!

The second step is to think about the relationships between different physical properties of the universe (which we collect as equations) and identify a relationship that allows you to connect what you know with what you do not know. In this circumstance, I draw upon my knowledge of the way the universe works to remember that all objects, in the absence of air resistance, experience the same acceleration due to gravity, which I know to be equal to 9.8 m/s^2 on Earth. This means that the mass isn't actually needed. I know that the first three equations on my equation sheet describe the way that objects move, and I can see that the second one would be the most useful for me, as it has only one variable that I do not know the value of:

$$y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$$

This is called the "second kinematic equation". I have written it here with y instead of x since we're discussing vertical motion. If we were to phrase this equation in English, we would say, "The height of an object is equal to the initial height plus the initial velocity in the y direction multiplied by the time, plus one-half the acceleration in the y direction multiplied by the square of the time."

On your page, right next to where you wrote down your given and needed information, you would write this equation:

Given	$y = y_0 + v_{y0}t + ½a_yt^2$
m = 3 kg	
y_0 = 1.5 m	
v_0 = 0 m/s	
Find: Δt	

Your job now is to substitute in your given information and then solve for time. Since we are wanting to know the time it takes the ball to hit the ground, we'll set y (final height) equal to 0 m:

Given	$y = y_0 + v_{y0}t + ½a_yt^2$
m = 3 kg	$0\ m = 1.5\ m + 0\ m/s * t + ½(-9.8\ m/s^2)t^2$
y_0 = 1.5 m	
v_0 = 0 m/s	
Find: Δt	

You will notice that the equation starts to look a bit messy with the units involved. I know it can be cumbersome, but keeping track of your units is a necessary part of physics. I also set the acceleration due to gravity as a negative number. That's because we specified that "up" is a positive direction by making the ground 0 m and the ball initially 1.5 m, so height is getting more and more positive as you go up. Because gravity pulls things down, its acceleration in this problem needs to be represented as a negative. There are times when we might switch around what we consider to be positive or negative to make problems easier to write, so it's useful to draw a little arrow in your paper to remind yourself what's positive for each problem:

Given	$y = y_0 + v_{y0}t + ½a_yt^2$	^+
m = 3 kg	$0\ m = 1.5\ m + 0\ m/s * t + ½(-9.8\ m/s^2)t^2$	
y_0 = 1.5 m	$0\ m = 1.5\ m - 4.9\ m/s^2 * t^2$	
v_0 = 0 m/s	$-1.5\ m = -4.9\ m/s^2 * t^2$	
Find: Δt	$t^2 = \sqrt{}(1.5\ m / 4.9\ m/s^2)$	
	$t = 0.58\ s$	

We see that it would take 0.58 seconds for this object to fall to the ground, if we ignore air resistance. You will learn how to do this problem and many more like it within the first two weeks of our class. The more knowledge you gain about a situation, the more you can specify. For example, now that I know the time, I could also easily find how fast the ball would be travelling. I could find the time it would take to reach a certain height above the ground and determine how fast it was travelling at that point. Eventually, you will learn how to involve other equations to know even more. You will learn what happens as objects are thrown, how much force it requires to make a certain object move a certain way, how energy plays a role in the universe, how objects spin and turn, how friction affects motion, what happens to objects when they collide in certain ways, and much more!

The key to success in our class is to be willing to practice these problems and do the work that is asked of you. You need to be honest with yourself about your knowledge and abilities and able to discipline yourself to do your homework, participate in class, and think critically. You are taking a class that is all about appreciating the universe and its workings. I promise you that your hard work and honest effort will be rewarded with a new perspective of your world.

Take care and enjoy your summer,
Dr. V

AP® PHYSICS 1 EQUATIONS

MECHANICS

$v_x = v_{x0} + a_x t$

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

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

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

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

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

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

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

$K = \frac{1}{2}mv^2$

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

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

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

$\omega = \omega_0 + \alpha t$

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

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

$\tau = r_{\perp}F = rF\sin\theta$

$L = I\omega$

$\Delta L = \tau\Delta t$

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

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

$U_s = \frac{1}{2}kx^2$

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

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

$\Delta U_g = mg\Delta y$

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

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

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

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

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

$U_G = -\frac{Gm_1 m_2}{r}$

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
$V = \ell wh$

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

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

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

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