2020 AP Summer Assignment
Annapolis Area Christian School

AP Physics 1

Ridings

Updated for 2020-2021

Overview & Instructions

This summer assignment is an overview of some essential skills you need for AP Physics 1. The class is an algebra-based course and therefore requires a proficiency in algebra, trigonometry, and geometry. You will use these concepts frequently throughout the entire year in addition to the new material you will be learning. This assignment exercises the mathematical concepts the course most frequently uses but is not exhaustive.

The topics covered are:

- Using the metric system
- Scientific Notation and Significant Figures
- Algebraically manipulating physics formulas (no values, just variables)
- Right triangle geometry (trigonometry)
- Plotting and understanding graphs

The following questions are meant to exercise each of these areas. It is assumed that you have already learned these concepts in previous classes. However, it may be that you need a review on these topics if you are struggling to reach the correct solution. Because of this, each section will begin with a list of tips/guidelines to get you started. In addition, there will be a list of online resources (including relevant videos) that will give you a more detailed overview of the problems. The resources will also be posted on the Google Classroom for AP Physics. You will receive an invitation to Google Classroom early in the summer.

The first submission for your summer assignment needs to be turned in on August 12, 2020. This will be done by simply emailing me an image of the work you have completed. This date is two weeks before the first day of school. Any questions you submit that are incorrect will be returned to rework. You may continue to resubmit work in order to have your answers re-evaluated. This assignment needs to be completed and correct by the first day of school: August 22, 2018. On that date you will hand in your corrected written solutions to me on the first day of class.

If you have any questions about completing the assignment, feel free to contact me at vridings@aacsonline.org.

Section 1: Using the Metric System

One of the most important skills in physics is the ability to easily convert between units within the metric system. In general, the standard units we will use are meters, kilograms, and seconds. All other units are built from these three measurements for distance, mass, and time, respectively. However, we are often called to convert between different measurements in a process called dimensional analysis. We will do this frequently throughout the year. The videos below may prove helpful.

https://www.youtube.com/watch?v=w0nqd_HXHPQ
https://www.youtube.com/watch?v=uHaKyNplino
https://www.youtube.com/watch?v=YAY8toXKUIY

The following is a prefix table for unit conversions within the metric system. These are the prefixes that most frequently appear within our science questions:

Prefix	Symbol	Scientific Notation
giga	G	10^9
mega	M	10^6
kilo	k	10^3
-	-	10^0
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}

Note that these prefixes do not need to be memorized. They will be provided to you on the AP Physics 1 exam formula sheet. That said, you will see them so frequently you will know them handily by May.

When using unit conversion (dimensional analysis), always remember to:

1) Set up the conversion ratio to cancel out the original unit and convert to the desired unit. This means if the unit you are converting from is in the numerator, the conversion ratio should be set up with this unit in the denominator. This will cancel out the unit you are converting. Keep doing this until you get to units you want for your answer.

2) Always label units for each step. This will help ensure you do not make mistakes.

3) Cross out units that have been canceled out and make sure that your final answer has been correctly converted to the new unit.

Carry out the following conversions using dimensional analysis. Show all your work!

1) Convert 28 km to cm.

2) Convert 85 cm/min to m/s

3) How many seconds are in a year?

4) Convert the speed of light 3.0×10^8 m/s to km/day

5) Convert 7.6 m^2 to cm^2.

6) Convert 8.5 cm^3 to m^3.

Section 2: Scientific Notation and Significant Figures

Scientific notation is a convenient means to write very large or very small numbers in a condensed formal without losing any information. One important item that often goes unnoticed is using scientific notation when expressions mathematical expressions. When done properly, it can make simplifying much easier. It is already assumed that you know how to represent a number in scientific notation, although the first video listed will give a brief tutorial if you are unfamiliar. Subsequent videos will show how to handle scientific notation in expressions, as well as using significant digits properly:

https://www.youtube.com/watch?v=Q_klLmTSyyw
https://www.youtube.com/watch?v=UADVIDjdaVg
https://www.youtube.com/watch?v=eCJ76hz7jPM

One additional note on significant figures that are not covered in the videos: exact values are considered to have an infinite number of significant digits. For example, if you are converting from meters to kilometers, you know that by convention there are 1000 meters within 1 kilometer. Therefore, the 1000 and the 1 are considered to have an infinite number of significant digits because they are *exact* values. This also includes exact mathematical values such as π, *e*, or other mathematical constants that may show up from time to time.

The following are ordinary physics problems. Write the answer in scientific notation and simplify the units. Use the appropriate number of significant digits. Include the appropriate units. Use the units shown, even if you are unfamiliar with them.

7) $T_s = 2\pi\sqrt{\frac{4.5\times10^{-2}\text{kg}}{2.0\times10^{3}\text{kg/s}^2}}$

8) $K = \frac{1}{2}(6.6 \times 10^2\text{kg})(2.11 \times 10^4\ \text{m/s})^2$

9) $F = 9.0 \times 10^{-9} \frac{\mathrm{N \cdot m^2}}{\mathrm{C^2}} \left(\frac{(3.2\times10^{-9}\,\mathrm{C})(9.6\times10^{-9}\,\mathrm{C})}{(0.32\ \mathrm{m})^2} \right)$

10) $\frac{1}{R_p} = \frac{1}{4.5\times10^{2}\,\Omega} + \frac{1}{9.4\times10^{2}\,\Omega}$

11) $e = \frac{(1.7\times10^{3}\,\mathrm{J})-(3.3\times10^{2}\,\mathrm{J})}{(1.7\times10^{3}\,\mathrm{J})}$

12) $K_{max} = (6.63 \times 10^{-34}\mathrm{J} \cdot \mathrm{s})(7.09 \times 10^{14}\mathrm{s}^{-1}) - (2.17 \times 10^{-19}\mathrm{J})$

13) $\gamma = \frac{1}{\sqrt{1-\frac{2.25\times10^{8}\,\mathrm{m/s}}{3.00\times10^{8}\,\mathrm{m/s}}}}$

Section 3: Algebraically Manipulating Physics Formulas

It often becomes handy, and in some cases essential, to rearrange equations in physics. The good news is that the AP exam will provide you with almost every equation you will need. The bad news is that sometimes you need to solve for a specific variable in that equation that requires you to rearrange the equation. Even more importantly, sometimes you will work on physics problems that do not have any values included at all and you are required to have a general sense of cause-and-effect that a properly rearranged equation may convey.

Mastering this process will make your life in AP Physics *a lot* easier. Otherwise, you will frequently find you produce math errors and/or incorrect solutions. Remember this important point: variables are numbers too, so you should treat them just like numbers when rearranging equations. The same rules for addition, subtraction, multiplication, division, squaring, square rooting, etc. still apply.

Below are a couple videos on the topic:

https://www.youtube.com/watch?v=chmHzxfM3L0
https://www.youtube.com/watch?v=quD1deDkNr0

Solve the following equations for the quantity indicated.

14) $y = \frac{1}{2}at^2$ Solve for *t*

15) $x = v_0 t + \frac{1}{2}at^2$ Solve for v_0

16) $a = \frac{v_f - v_0}{t}$ Solve for v_f

17) $F = k\frac{m_1 m_2}{r^2}$ Solve for r

18) $F = k\ \frac{m_1 m_2}{r^2}$ Solve for m_1

19) $T = 2\,\pi\sqrt{\frac{L}{g}}$ Solve for *L*

20) $T = 2\,\pi\sqrt{\frac{L}{g}}$ Solve for *g*

21) $\frac{1}{f} = \frac{1}{d_0} + \frac{1}{d_i}$ Solve for d_i

22) $qV = \frac{1}{2}mv^2$ Solve for *v* (lower case *v*, not upper class *V*)

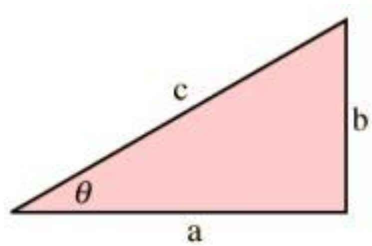
Section 4: Right Triangle Geometry (Trigonometry)

In conjunction with vectors (which we will cover in the first week of class), we will use triangle geometry extensively within the class. As such, it becomes very handy to be well-versed with your basic trigonometric relationships, including inverse functions. If you don't know SOH CAH TOA like the back of your hand, now would be a great time to reinforce that knowledge.

Below are some basic videos on the topic:

https://www.youtube.com/watch?v=Ylix5mlXNCo
https://www.youtube.com/watch?v=znR9tW4AiZI
https://www.youtube.com/watch?v=15VbdqRjTXc&t=1s

For the triangle below, use right triangle trigonometry and the Pythagorean Theorem to solve the following problem. Make sure your calculator is in degree mode.



23) $\theta = 55^o$ and $c = 32$ m, solve for *a* and *b*.

24) $\theta = 45^o$ and $a = 15$ m/s, solve for *b* and *c*.

25) $b = 17.8$ m and $\theta = 65^o$, solve for a and c.

26) $a = 250$ m and $b = 180$ m , solve for θ and c.

27) $a = 25$ cm and $c = 32$ cm, solve for b and θ.

28) $b = 104$ cm and $c = 65$ cm, solve for a and θ.

Section 5: Plotting and Understanding Graphs

We will have several questions throughout the semester that will require you to interpret data within graphs. This will also occur in labs where you will need to collect data and represent it in a graph. Being able to properly represent and interpret graphs are an important skill and the following problems will help exercise that.

First, it is important to accurately plot the data. Your x-axis should include the independent variable (or the variable that is being controlled in an experiment) and the y-axis should include the dependent variable, or response. Choosing a feasible scale is an important piece here. The lowest value on your x-axis should be just less than the lowest value for your independent variable and the largest value on your scale should be just greater than the largest value in your independent variable. The same is true for the y-axis and the dependent variable. You should ALWAYS label your axes and put a title on the plot. Units should also be included on the axes and numerical intervals on the plots should be clearly labeled. After doing all of this, you may begin to plot data.

Plotting the data points will indicate their relationship. There can either be a positive, negative, constant, or no relationship in the data. A positive trend will occur when an increase in your dependent variable coincides with an increase in your independent variable. A negative trend will occur when a decrease in your dependent variable coincides with an increase in your independent variable. A constant relationship between the variables usually shows up when the data appears to fall on a flat line. No relationship occurs if the data seems randomly scattered around the whole plot.

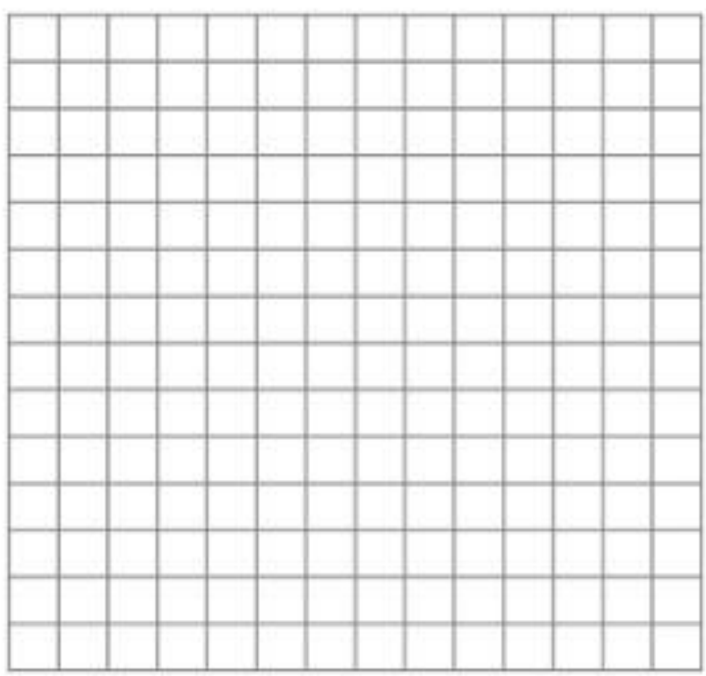
After this, it is a good idea to include a trend line (line of best fit or regression line), or curve that follows the general behavior of the data. This is useful to help make predictions in the data set. If you have a particular value on your x- or y-axis that you wish to relate to the opposite axis, the trend line makes it easier to spot that relationship. There are mathematical ways to plot the best trend lines, but we will not cover those in the summer assignments. For now, a smooth curve (or straight line if appropriate) will suffice (in other words, don't connect the dots!)

Plotting using your computer is highly encouraged, and there is a whole slew of videos out there that give instruction on the basics of data plotting, however, it may be worth your while to learn how to do this in Excel. Plus, it makes your lab reports look good compared to doing them by hand, which can get messy. Being proficient in Excel is also a skill that is very useful beyond just high school physics! Here is a tutorial that may be helpful:

https://www.youtube.com/watch?v=bYf6qO-iBW0

29) Plot a graph for the following data recorded for an object falling from rest:

Velocity (ft/s)	Time (s)
32	1
63	2
97	3
129	4
159	5
192	6
225	7



30) After plotting the graph, what kind of curve did you obtain (linear, exponential, etc)?

31) What is the relationship between the variables (positive, negative, constant, etc)?

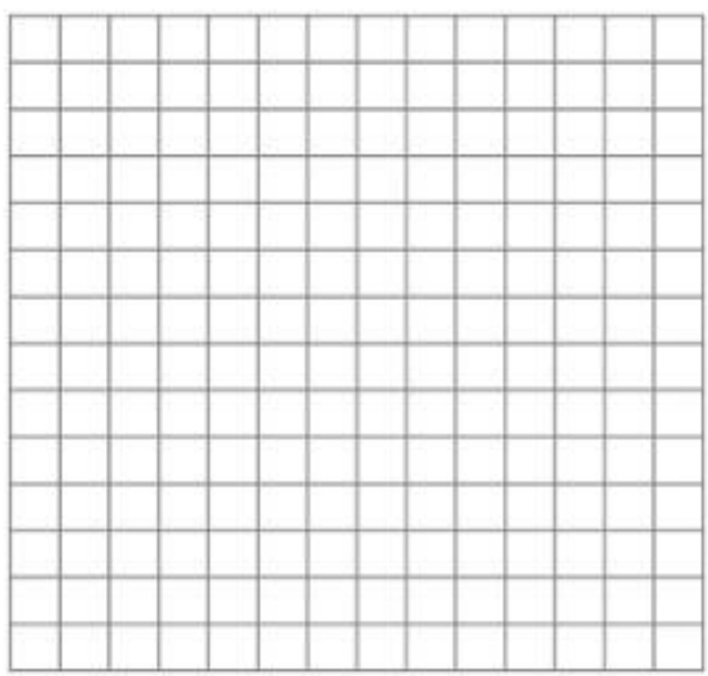
32) Using the trend line in your graph, what do you expect the velocity to be after 4.5 s?

33) Using the trend line in your graph, how much time is required for the object to attain a speed of 100 ft/s?

34) Plot a graph for the following data recorded for an object falling from rest:

(Note that you do not need to know what these quantities are in order to plot the graph).

Frequency (kHz)	Wavelength (m)
150	2000
200	1500
300	1000
500	600
600	500
900	333



35) What kind of curve did you obtain?

36) What is the relationship between the variables?

37) Using the trend line in your graph, what is the approximate wavelength of an electromagnetic wave of frequency 350 Hz?

38) Using the trend line in your graph, what is the approximate frequency of an electromagnetic wave of wavelength 375 m?