AP Physics 1 Summer Assignment 2017

Introduction

Welcome to Mr. Dempsey's AP® Physics 1 course, which hopefully will prove to be one of the most interesting & rewarding classes that you will take in high school. However, please be advised that both the course and the AP® exam will be challenging. You already know that AP® classes are taught as college courses—not just college-*level* courses, but actual college courses. This means that:

- I will do as much as I can to *help* you learn, but you and you alone are responsible for learning and understanding everything covered in class.

- I will give you assignments and fair warning about due dates and test dates, but I will not chase after you. If you were absent and you need to turn in an assignment late, *you* need to find out about the assignment, obtain a copy, do it, and to show it to me; do not assume I will ask you for it.

- If you're having trouble with something, *you* need to be proactive about learning it, either by coming in for help after school, consulting with your classmates, or by getting outside help from somewhere else. This expectation is effective *immediately*, starting with this summer assignment. Remember—*your* job is to succeed; *my* job is to do everything in my power to *help* you be successful, but I can do my job only to the extent that you do yours.

Even if you do all of the above, the AP® Physics 1 exam does not test whether you merely know the relevant physics concepts and equations, but how well you can apply them to complex problems and situations. The AP® Physics 1 exam is at least as much about problem-solving as it is about physics content. If you work hard, you will most certainly learn much about how the world works, and will improve over time. Hard work, however, will not guarantee a high score on this particular test. It will also take tenacity, creativity and an ability to think through problems logically, not merely memorize a pattern.

Course & Contact Information

Course information: `Google Classroom Code Class code 7uky41.` ***JOIN THIS CLASS!***

Mr. Dempsey's email: `mdempsey@spsd.us`

I will read and respond to email sent to either address throughout the summer and school year.

About the Summer Assignment

The goals of this summer assignment are to give you an introduction to the kinds of thinking you need for AP® Physics 1. I expect you to struggle with the problems. I expect you to be frustrated with some of them. I do not expect you to be able to do all of them without help.

The assignment consists of a math skills diagnostic test, three sets of problems and a lab experiment. All parts of this assignment are due by **Monday September 11, 2017**.*

Do not leave this assignment until the last week of vacation. If you do, you will be sorry!

Recommended Supplies

I recommend the following supplies for AP® Physics 1:

Scientific calculator. It does not need to be a graphing calculator, though you are welcome to use a graphing calculator if you already have one.

Laboratory notebook. This should be a composition book. Graph paper pages are preferred, so you will already have graph paper for experiments that need a graph.

AP® Physics 1 exam review book. (Optional but highly recommended) There are several, all of which have their good points and bad points. I have a slight preference for *Princeton Review* and *SparkNotes*, and I tend to avoid *Baron's*.

Warning about Copying and Other Forms of Cheating

Almost all students copy homework assignments, tests, and anything else they can get away with from each other and from the Internet. AP students do this more than most, because grade-wise, you have the most at stake. However, the more you cheat, the more you limit your learning to only concepts and equations. If you get through the year by copying from other students or the Internet, I can almost guarantee that you will get a 1 on the AP exam, and you will complain that you learned nothing from your AP® Physics 1 class. It will be very difficult for me to know if and when you are crossing that line, though on labs in particular if I identical text, format and flow I will hold you accountable for cheating.

Summer Assignment Part 1: Math Skills Assessment

Simplifying Expressions

1. **Simplify the following expression:** $\left(5x^3 - 3x^2 + 2x + 1\right) - \left(x^3 + 4x^2 + 6x + 3\right) =$

2. **What does** $\left(x^4 z^3\right)^5$ **equal**

3. **What is the sum of (** $5x^2 + 3x + 5$ **) + (** $8x^2 - 5x + 5$ **)**

4. **Simplify** $\dfrac{3}{a+b} - \dfrac{2}{a+b}$

5. **Simplify** $\dfrac{\frac{3}{4} - \frac{2}{3}}{1 + \frac{3}{5}}$

6. **Simplify** $4^{\frac{3}{2}}$

Solving Two Equations for Two Unknowns

7. **Solve the following for x and y:** $\begin{cases} 5x + 6y = 12 \\ 3x + 5y = 3 \end{cases}$

Using the Quadratic Formula

8. **Solve the following for x using the quadratic formula:** $8x^2 + 6x - 5 = 0$

Quadratic formula: for any function in the general form $ax^2 + bx + c = 0$,

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

Linear Equations and Proportions

9. **What is the slope of the line of the following function** $\frac{9x + 2 - y}{3} = 4$

10. **Which of the following represents a function whose value decreases as x increases**

$y = x^2 - 3$

$y = 3x - 4$

$y = 4 / x$

$y = \sqrt{x}$

Unit Conversions

11. **Convert the following:**

15 miles per hour to meters per second

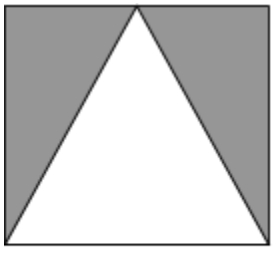
365.25 days/year to microseconds/year

Some Basic Word Problems

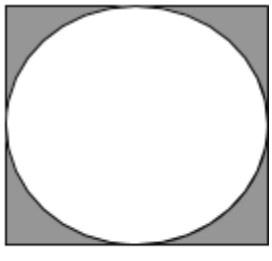
12. **A triangular shaped piece of property has a height that is 4 feet longer than the base length. The property has a total area of 60 square feet. What is the base length and the height of this triangle?**

13. The height of a freely falling object is given by the relationship $h = -3t^2 + s$, where t = the time the object has been falling and s is the initial height of the object. If the object was dropped from an initial height of 120 feet how long would it take to hit the ground?

14. Find the area of the shaded region in each of the figures below.



8 meters



Summer Assignment Part 2: Review of Uncertainty and Significant Figures

The College Board writes, "Given the emphasis on time spent in the laboratory, students should be introduced to the methods of error analysis including and supported by mean, standard deviation, percentage error, propagation of error, and linear regression, or the calculation of a line of best fit. Colleges will expect students to be familiar with these methods and to have carried out the procedures on at least some of the laboratory experiments they undertake...."

Significant Figures ("sig figs") are a poor approximation of how to propagate uncertainty through a calculation, which is how we will address uncertainty in AP® Physics 1.

The purpose of the following sig fig problems is to give you a sense of the actual uncertainty that sig figs are trying to get you to approximate.

1. Assuming that the rule for significant figures of "assume the last sig fig is ±1" is true, give the percent uncertainty ("percent error") for each of the following measurements:

    a. 2.75 m

    b. 1.3 m

    c. 8.124 m

    d. 0.0175 m

2. Add up each of your percent uncertainties from parts (a–d) to find the total percent uncertainty.

3. Perform the following calculation:

$(2.75 \times 1.3) \div (8.124 \times 0.0175)$

but *do not round* your answer. (You will do this in question #4.)

4. Round your answer to question #3 to the "correct" number of sig figs.

5. What is the percent uncertainty of #4 (again, assume the last sig fig is ±1).

6. Do you think the actual uncertainty is closer to your answer to question #2, or your answer to #5? Explain.

Summer Assignment Part 3: Review of Conversions

These conversion problems are intentionally evil (especially #2). If you can do these correctly, you totally understand conversions.

1. One mile is 8 furlongs. One mile is also 5,280 feet. A fortnight is two weeks. If the speed limit on Route 128 is 55 miles per hour, what is that in furlongs per fortnight?

2. One gallon is 128 fluid ounces. One gallon is also 231 cubic inches. One inch is exactly 2.54 cm. One parsec is 3.0857×10^{16} m. The prefix "atto" means 10^{-18}. One fluid ounce is how many cubic attoparsecs? (*Hint: if you start with the number of meters in an attoparsec and cube both sides, you will have the number of cubic meters in a cubic attoparsec.*)

Summer Assignment Part 4: Rearranging Equations

In AP® Physics 1, it is not enough to only be able to solve algebra problems using numbers. The College Board will expect you to be able to rearrange expressions and substitute one expression into another.

1. Given $a = 2bc$ and $e = c^2d$,

   a. Rearrange the first equation to solve for *c.*

   b. Substitute your expression from part (a) into the second equation and simplify to give an expression for e in terms of *a*, *b* and *d*.

2. Given $w = 3/2xy^2$ and $z = q/y$

   a. Rearrange the first equation to solve for *y*.

   b. Substitute your expression from part (a) into the second equation and simplify to give an expression for *z* in terms of *q*, *w* and *x*.

   c. Based on your expression in part (b), if you wanted to increase the value of the variable *z*, what changes should you make to the values of *q*, *w*, and/or *x*?

   d. A change of the same magnitude in which of the variables *q*, *w*, or *x* would give the largest proportional change in the value of *z*?

Summer Assignment Part 5: Experiment

- The laboratory assignment is to build, troubleshoot and optimize a device that can time an interval of exactly ten seconds, using whatever materials you can find around your house.
- You will bring your timer into school, where you will compete against your classmates to see whose timer comes closest to exactly ten seconds. ***You will also be required to turn in a google classroom lab report describing the design, building, and operation of your timer***.
- The requirements for the timer contest are:

1. Your timer may not use electricity or any kind of clock.

2. Your timer must perform a minimum of *two separate and distinct "actions*." A transfer of energy from one physical object to another must occur between one "action" and another. For example, a marble that rolls down a ramp and pushes a lever, which rings a bell would count as two distinct actions:

   a. Marble rolls down ramp and hits lever.

   b. Lever swings and hits bell.

3. Your timer may not be an unmodified "off-the-shelf" item. If you use a pre-made device or object as part of your timer, you need to modify it in some substantial way that affects how you use it to measure ten seconds. (Email me if you're not sure.)

4. If you want to build a timer that performs an action that could be potentially dangerous (*e.g.,* projectiles, fire, live animals, *etc.*), you must discuss any potentially dangerous action(s) in detail with me beforehand. You must convince me that your timer will be safe for yourself and your classmates before you build it and bring it in. (Email me if you're not sure.)

5. If your timer does something repetitive, you may count a specific number of repetitions. For example, if the final action of your timer is a ball on a string that winds around a pole, you may measure ten seconds by how long it takes the ball to go around the pole some specific number of times.

6. Your timer may not require human interaction after it has started (except for counting repetitions of some action, as described in rule #5 above).

7. You must declare *in advance* how your timer will indicate when ten seconds has elapsed. For example, having a gadget that flops around on the floor randomly while you count in your head "one-Mississippi, two-Mississippi..." is not acceptable.

8. You have a maximum of two (2) minutes to set up your timer.

9. Students may help each other, but each student must have his/her own timer and write-up.

10. Elapsed time will be measured by stopwatch. Because of the limits of human reaction time, results within 0.1 s of each other will be considered equivalent. (This may result in multiple winners.)

11. If your timer completes all of its actions in less than six (6) seconds, you will lose 15% from your grade. (This is because some people fail to do the assignment in advance and cobble together whatever they can at the last minute. These timers almost always perform all of their actions within a couple of seconds. If you do this, you should expect to receive a lower grade.)

Your write-up will be submitted on google classroom should include the following sections:

Title & Objective: a descriptive title and the objective (purpose) of the experiment.

Background: your experimental objective and your overall approach to meeting it.

Procedure: a detailed description of how you built your timer and how you operate it.

Data & Observations: list the time for each of your trial runs (you need a minimum of eight separate data points), and a description of any adjustments/changes you made after each one.

Analysis: calculations, quantitative and qualitative error analysis. What is your average run time based on all your runs, and to what percent accuracy can your timer measure based on your tests?

Conclusion: a 1–2 sentence summary of whether or not you achieved your objective.

The lab write-up format that we will use is relatively simple and straightforward. The following is an illustrative example of what it might look like. A rubric is attached to the end.

Sample Write-Up. This is a Sample Write up for a different lab, but it should give you an idea of what a lab report will look like. Note the uncertainty section in particular. Can you tell me how good your "clock" is at measuring time? A grading rubric is included at the end.

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Name: Stu Dent **Date:** 6/13/16
Lab Partners: Rita Book, Joe King
Title: Determining the Velocity of a Rolling Ball
Objective: to measure the average velocities of a ball rolling down a ramp, starting from different heights.

NOTE: *Your Background needs to describe how you intend to obtain the data that you need in order to meet the objective. If you can measure all quantities directly, describe (in a sentence or two) how you will produce and measure the data.*

If you cannot measure a quantity directly, start with a formula that includes it and describe (in a sentence or two) how you will produce and measure each quantity in the formula.

If one or more of the necessary variables in the formula cannot be measured directly, apply additional formulas as above until you can produce and measure each quantity you need.

Background: We can't measure directly, so we will solve for it using the formula . We can measure d and t directly, and from these we can calculate . $v_{avg} = \Delta d/t$.

To measure d and t, roll the ball down a ramp, starting from different positions on the ramp. Mark fixed distance (d) and measure time (t).

Notes:

Everything you write down during the experiment goes in the Notes section, ***not on a separate piece of paper****! What happened when you actually did the experiment is the most important part of it. Think of it as both your scrap work section and where you jot down issues you encounter that you might mention later in your report. If your "notes" section looks too neat, I will assume you copied it over and demand that you staple the original scrap of paper into your notebook in order to receive credit for this section!*

The "Notes" section should be on its own page(s). The Notes section should start on a new page, and you should start another new page immediately afterwards.

Procedure:

1. Measure the width of one tile in the hallway.
2. Count 10 tiles on the floor in the hallway.
3. Place a ramp that is 2.45 m long and 0.31 m high so that the end of the ramp is at the edge of a tile.
4. Mark the start and end point with masking tape.
5. Place the ball at five different points on the ramp and let it roll down the ramp and down the hallway.

Every experiment must have a sketch. *Remember to label quantities as well as objects.*
The dimensions of the ramp and the floor tiles are relevant to the experiment , so you need to include them.

6. Record the time it takes the ball to cross the "finish line" (end of the 10th tile past the starting point) for each trial.
7. Calculate the velocity of each trial.

Data & Observations:

Usually the first columns on the left will be your independent variables, then your dependent variables, then your calculated values.

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Trial #	Start distance (from end of ramp) (m)	Distance on floor (m)	Time (s)	Average Velocity $\left(\frac{m}{s}\right)$
1	0.5	7.5	4.2	1.79±0.10
2	1.0	7.5	3.7	2.03±0.12
3	1.5	7.5	2.6	2.88±0.17
4	2.0	7.5	2.4	3.13±0.18
5	2.47 (top)	7.5	2.1	3.57±0.21

Analysis:

Discussion should give an overview of the results. The minimum is 1–2 sentences for a simple lab, but a complex experiment might require anywhere from a couple of paragraphs to several pages.

Discussion:

Conclusion:

We calculated the velocities of balls that rolled down a ramp from different heights. The velocities ranged from starting 0.5 m before the end of the ramp to starting from the top of the ramp (2.47 m before the end). sm0.101.79sm0.213.57

Your conclusion needs to restate:

1. A summary of what you did (one or two sentences).

2. Your major result(s).

3. You don't need to repeat sources of uncertainty or errors in your conclusion unless you think they actually had a significant effect on your experiment.

Analysis:

Discussion:

Discussion should give an overview of the results. The minimum is 1–2 sentences for a simple lab, but a complex experiment might require anywhere from a couple of paragraphs to several pages.

The average velocity increased as the point of release of the ball increased.

Calculations:

Sample calculation for average velocity:

- *Notice that the formula appears first with variables and then with numbers.*
- *Remember to include the units!*

$$v = \frac{d}{t}$$

$$v = \frac{7.5\,m}{4.2\,s} = 1.79\frac{m}{s}$$

Uncertainty

Quantitative Uncertainty Calculation

Assume reaction time is about 0.1 s.

Note: average startle response reaction time is 210–220 ms. However, this can be significantly less if the person can anticipate the start and stop events. A reasonable educated guess for a person timing a predictable event with a stopwatch is about 100 ms or 0.1 s.

Relative error is $\frac{0.1}{1.79} = 0.0559$

(Equivalent to 5.59% error.)

Estimated error in distance measurement is about 2 mm.

Relative error is $\frac{2}{750} = 0.00267$ (Equivalent to 0.267% error.)

Total relative error is 0.0559 + 0.00267 = 0.0586 (Equivalent to 5.86% error.)

Absolute error is $0.0586 \times 1.79\frac{m}{s} = \pm 0.10\frac{m}{s}$.

Detailed results with uncertainties are listed in the data table.

To convert relative error to absolute error, multiply the relative error by the measurement.

Sources of uncertainty:

- Ability to tell exactly when the ball crossed the tape might have varied.
- Ball did not roll in a straight line.

*Sources of uncertainty should **never** include human error unless you think it actually happened and was unavoidable. **Never** say anything that suggests that you or your lab partners might be stupid (such as "We might have written down the wrong number." or "We might have done our calculations wrong.")*

Lab write-ups throughout the year will be graded according to the following rubric (or one that is very similar). Some items that are crossed out or *changed.* The original is the generic lab rubric, and the changes reflect specific differences that apply specifically to this write-up.

Title, Objective, etc.

☐ title included in report
☐ objective included in report
☐ title & objective both correctly describe purpose of experiment

Background

☐ section included in report
☐ explains which measurements need to be taken and why
☐ briefly describes how each quantity will be measured *what can be changed to adjust the time*
☐ explains how the desired quantity will be calculated from the measurements *adjusted as needed*

Notes

☐ section included in report

Procedure

☐ section included in report
☐ all significant materials explicitly listed (either separately or mentioned within steps)
☐ describes what was done to take each data point *build and operate the timer*
☐ mentions equipment used for each measurement
☐ includes *labeled* sketch (names & approximate dimensions)
☐ easy to understand
☐ complete (someone following it exactly would have a hard time doing anything different)

Data & Observations

☐ section included in report
☐ lists all measurements including units
☐ gives uncertainty for each measured quantity

Analysis

☐ section included in report
☐ includes 1-2 sentence discussion of the results
☐ calculations shown
☐ calculations are correct
☐ uncertainty calculations shown & are correct
☐ lists at least 2 sources of uncertainty (other than human error)

Conclusion

☐ section included in report
☐ gives one-sentence summary of final result

Format, *etc.*

☐ lab partners listed (*you must build your own circuit board*)
☐ sections in correct order
☐ hand-written in lab notebook
☐ notes on separate page(s) from the other sections of the report