AP® Physics 1 Information & Summer Assignment 2017

Introduction

Welcome to Mr. Bigler's AP® Physics 1 course, which may prove to be one of the most fun & rewarding classes that you will take in high school. However, 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 I can 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. Unfortunately, while your previous classes have probably taught you to be a decent writer, you have probably learned at least as much about how to *avoid* problem solving ("Whenever you see a problem that looks like this, just memorize and use this formula.") than about how to approach and solve an unfamiliar, complex, multi-step problem methodically. Consequently, AP® Physics 1 presents a challenge for which you are almost certainly ill-prepared, and you will probably find the AP® Physics 1 course and exam to be harder than most (if not all) of the other AP® courses and exams that you will take.

Course & Contact Information

Course information: http://www.mrbigler.com/AP-Physics-1

Mr. Bigler's email: biglerj@lynnschools.org, mrbigler@mrbigler.com

You can download just about everything you need (including replacement copies of this summer assignment and reference tables) from the website. I will read and respond to email sent to either address during the summer and throughout the school year.

About the Summary Assignment

The primary goal of this summer assignment is to give you an introduction to the type of thinking you need for AP® Physics 1. I expect you to struggle. I expect you to be frustrated. I do not expect you to be able to do all of this assignment without help. *Nevertheless, I do expect you to do all of this assignment*.

The assignment consists of a math skills diagnostic test, a handful of problems, and a lab experiment. All parts of this assignment are due by **Monday September 11, 2017**.[*] If you do not complete the assignment, *I reserve the right to contact your guidance counselor and recommend that you be switched out of the class*.

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

Required Supplies

The following supplies are required for AP® Physics 1:

- **Scientific or graphing calculator**. A $15 scientific calculator (such as a TI-30) is sufficient. If you already have a graphing calculator, you can use it.
- **Laboratory notebook**. This must be a composition book *with graph paper pages*. They cost about $1.50–2.00 from stationery stores. (Students in past years have used lab notebooks without graph paper pages, and have lost points as a result of not plotting graphs accurately on graph paper.)

Recommended Supplies

I recommend the following supplies for AP® Physics 1:

- **AP® Physics 1 Class Notes**. These are the same notes that I will project on the SMART board and use in class. These will be revised over the summer and available for download and/or purchase in the fall. You can download an electronic copy (PDF) for free from my website. Most of my former students highly recommend purchasing a printed copy, so you can write directly in it throughout the year and take it with you when you go to college. Look for the heading "AP® Physics 1 Class Notes" on the class web page, and follow the links for the electronic version and/or the print version.
- **5 Steps to a 5 AP® Physics 1 exam review book**. This is an excellent book with short reviews of each topic and sample questions. I have copies to issue, but if you want to write in yours and keep it, you can buy one for about $10.

[*] If your class does not meet on that day, the assignment will be due the next class day. For students who switch into AP® Physics 1 after the last day of the 2016–17 school year, the assignment will be due two weeks later.

- **500 AP® Physics 1 Questions to Know by Test Day.** This book contains AP questions from every topic, and will be a valuable review for tests during the year as well as the AP exam. I have copies to issue, but if you want to write in yours and keep it, you can buy one for about $10.
- ***Physics Fundamentals* textbook**, by Vincent P. Coletta. This is an optional textbook, which you can use to supplement the class notes and discussion. I can issue you a book if you want to sign one out. You can also download a PDF version of the book for free by following the link from the class web page. The username is my last name, and the password is my favorite phrase (all lower case, and including the space).
- ***The Cartoon Guide to Physics***, by Larry Gonick and Art Huffman. This book is an easy read and it provides excellent visual explanations of the topics in AP® Physics 1.

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 low-level application of equations. If you get through the year by copying from other students or the Internet, it is virtually certain that you will get a 1 on the AP exam, and you will complain that you learned nothing from your AP® Physics 1 class.

If I catch you cheating or plagiarizing on a test or major assignment, a parent or legal guardian will need to give me permission to let you re-take the test or re-submit the assignment (in either case, for reduced credit). You will not be allowed to re-take or re-submit until I have a voice conversation (either by telephone or in person) with your parent or guardian first.

Note that, as with college courses, knowingly *or unknowingly* allowing someone to copy your work and submit it as their own is also considered cheating, and will incur the same penalty. It is *your responsibility* to protect your work and prevent others from copying it.

Summer Assignment Part 1: Math Skills Assessment

1. Sign on to Mr. Bigler's MOODLE site at `http://www.mrbigler.com/moodle` using your school login ("stu" plus your ID number) as your username. (The first time you log in, your starter password will be "98765" and you will have to change it.) Email me if you have trouble doing this or if I need to create a MOODLE login for you. *If you wait until the end of summer to try this and email me at the last minute, I will not grant you an extension of the deadline.*
2. Navigate to the AP® Physics 1 course (if you're not already there) and scroll down to the Summer Assignment section.
3. Take the quiz titled "Math Skills Assessment".
4. Keep re-taking the assessment until you achieve a score of 70% (50/71) or higher.

Summer Assignment Part 2: Problems & Questions

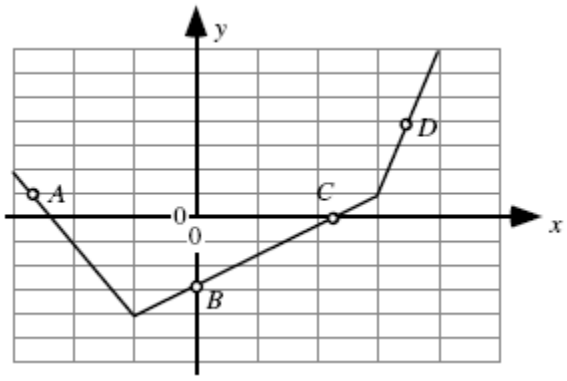
Please do these problems on separate paper. (*I.e.,* please do not try to squeeze the answers in on the assignment sheet.)

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 5280 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.*)

3. On the following graph:



Rank from greatest to least the slopes of the section of the graph that contains each of the labeled points A, B, C, and D. *I.e.,* the section of the line that contains the steepest positive slope will be ranked "greatest". The section of the line that contains the steepest negative slope will be ranked "least."

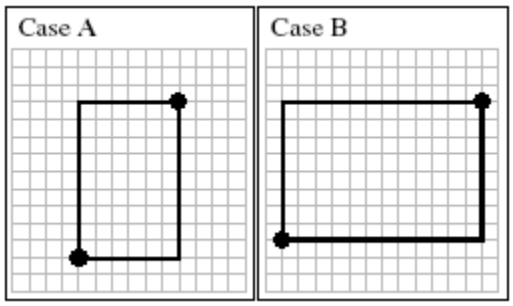
1st (greatest) ____ 2nd ____ 3rd ____ 4th (least) ____

____ All of the sections of the graph have the same slope.

____ It is not possible to compare the slopes of some or all of the sections of this graph.

Write a short paragraph explaining your rationale.

4. In each the diagrams labeled "Case A" and "Case B" below, a rectangle is drawn on a grid.

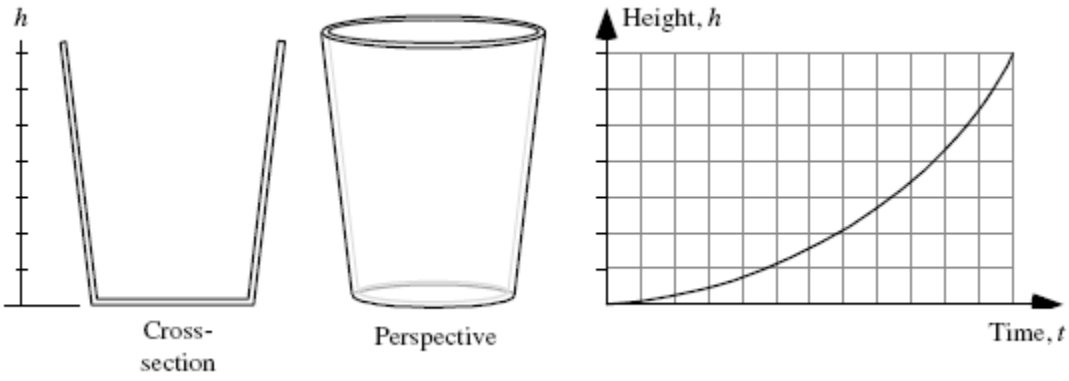


A student makes the following statement in comparing the slopes of the diagonal lines connecting the corners marked by dots:

> *"The steepness of a line depends on how much the line rises compared to its run. For Case A the rise is 9, and the run is 6, and the difference between rise and run is 3. For Case B, the rise is 8 and the run is 12 and the difference is minus 4. Case B has a smaller slope than Case A, and in Case B the slope is negative."*

Is the student correct? Write a short paragraph explaining either why the student is correct, or explaining what is wrong with this student's statement and giving the correct answer, along with an explanation.

5. A glass is tapered so that it is wider at the top than at the bottom. The glass is filled, at a constant volumetric flow rate of 4 ml per second. A student graphs the height of the water in the glass as a function of time as shown:



The teacher marked the student's graph wrong. Describe what the shape of the graph should have looked like, and write a short paragraph explaining why.

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.

Because many students struggle with this skill, the variable of interest in each expression is shown in ***bold underlined*** type.

6. Solve $5(\underline{\boldsymbol{x}}-3)=y(4-3\underline{\boldsymbol{x}})$ for *x.*

7. Solve $d=\sqrt{\frac{3\underline{\boldsymbol{h}}}{2}}$ for *h.*

8. Solve $y=\frac{2p\underline{\boldsymbol{t}}}{p-\underline{\boldsymbol{t}}}$ for *t.*

9. Solve $a(\underline{\boldsymbol{q}}-c)=d$ for *q.*

10. Substitute your expression for *q* from question 9 above into the equation $4(\underline{\boldsymbol{p}}-2q)=3\underline{\boldsymbol{p}}+2$, and solve the resulting equation for *p.*

11. Given $w=\frac{3}{2}x\underline{\boldsymbol{y}}^2$ and $\underline{\boldsymbol{z}}=\frac{q}{y}$

    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 could you make to each of the values of *q*, *w*, and *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 3a: Experiment

The laboratory assignment is to build, trouble-shoot 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.

Your timer will be scored based on the error (difference between your time and ten seconds) divided by the number of "actions" your timer performs (see item #2 below for explanation). The *lowest* score wins two "up quarks" of extra credit—worth ½ point on your final quarter grade.

You will also be required to turn in a lab report (handwritten in your notebook) 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 each "action" and the next. For example, a marble that rolls down a ramp and pushes a lever, which rings a bell would count as three actions:
    a. Marble rolls down ramp. (Energy is in the marble.)
    b. Marble hits lever. (Energy is transferred to the lever.)
    c. Lever hits bell. (Energy is transferred to the 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). If your timer needs a "nudge", each nudge negates one action.
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 separate timer and write-up.
10. Elapsed time will be measured by Mr. Bigler, using a hand-held stopwatch. Because of the limits of human reaction time, times will be rounded to the nearest 0.1 s. (This may result in multiple winners.)
11. If your timer completes all of its actions in less than six (6) seconds, you will lose 10% 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.)

Summer Assignment Part 3b: Write-up

Your write-up should include the following sections:

- **Title & Objective**: a descriptive title and the objective (purpose) of the experiment.
- **Experimental Design**: a high-level description of your timer that describes each of the major actions, using the appropriate physics terms (ramp, pendulum, *etc.*)
- **Procedure**: a detailed description of the design and construction of your timer, and how you operate it.
- **Data & Observations**: list the times for each of your trial runs (you need a minimum of *eight* separate data points, at least *three* of which must be from the device in its final configuration), and a description of any adjustments/changes you made after each one.
- **Analysis**: a 2–3 sentence discussion of your results, including any difficulties you encountered, and any trends in the data.
- **Conclusions**: a 1–2 sentence summary of how well you achieved your objective (include the average of your elapsed time), and suggestions for improvements.

Note that the above requirements and descriptions are specific to this experiment—experiments that involve more quantitative measurements will have a more extensive analysis section.

Sample Write-Up

The following is an illustrative example of what a lab write-up for the 10-second timer experiment might look like. Note that lab write-ups must be *handwritten in your lab notebook*.

Name: Stu Dent **Date**: 6/9/17

Title: Construction & Testing of a 10-Second Timer

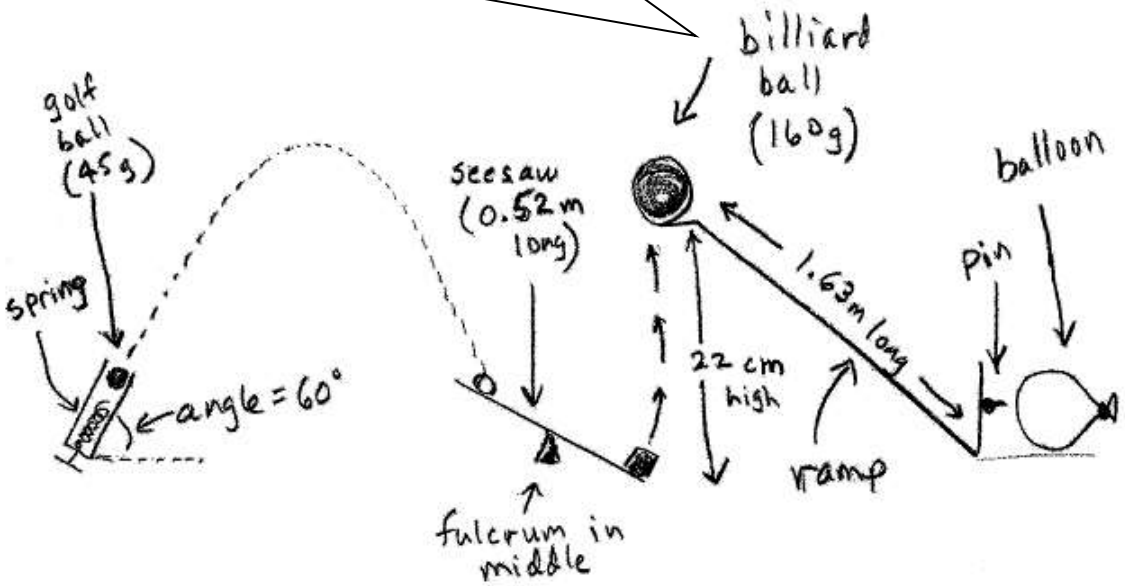
Objective: to build and test a mechanical device that can exactly time a 10-second interval.

For an experiment such as this one, in which you are building, debugging, testing, and adjusting a device, the experimental design section is a descriptive list of the major components of the device and how they are connected.

Experimental Design: The timer design is a launcher that uses a spring to launch a projectile (golf ball), which lands on a lever (seesaw). The lever hits a second ball (billiard ball), which rolls down a ramp and collides with a pin, which punctures a balloon. The dimensions of the apparatus are such that the total elapsed time from the explosion to the balloon popping is ten seconds.

A labeled sketch of the apparatus is shown below:

*Note that the sketch needs to include labels **and** **dimensions/quantities** for **each** object, and it needs to show how each object is connected to or interacts with the other objects.*



Procedure:

1. Set up the apparatus as shown in the diagram in the Experimental Design section above.
2. Load the golf ball into the launcher and pull back the firing knob approximately 4–5 cm.
3. Count down and release the knob while a second person starts a stopwatch.
4. Record the time it takes from the time the launcher is released until the balloon pops.

Data & Observations:

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

Trial #	Time (s)	Adjustments made afterwards
1	3.4	Made the ramp higher.
2	2.6	Made the ramp lower.
3	5.6	Made the ramp even lower.
4	7.7	Pulled the spring back less.
5	6.9	Pulled the spring back farther and lowered the ramp more.
6	9.7	No changes.
7	9.8	No changes.
8	9.5	No changes.

Analysis:

In its final configuration, the timer lasted an average of 9.67 s.

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:

Raising the height of the ramp made the billiard ball roll faster, which decreased the time. Pulling back farther on the spring caused the golf ball to go higher, which increased the time. The final ramp height was 22 cm. With this height, pulling the spring back 4–5 cm gave good results.

Sources of uncertainty:

- The launcher was hand-held and the angle might have varied.
- The spring was pulled back by hand and the distance might have varied.

*Sources of uncertainty should refer to **specific items** from your set-up or procedure. **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.")*

Conclusions:

A mechanical timer was built and tested. Its average elapsed time was 9.67 s. Some improvements might include a stand in order to launch at a more consistent angle, and a guide for the launcher to ensure that the spring is pulled back for a consistent distance.

Your conclusions section should include:
1. *A summary of what you did (one or two sentences).*
2. *Your major result(s), including uncertainty if applicable.*
3. *Suggestions for improvements. These should address the sources of uncertainty that you listed above.*

***Note:** every year, a few students turn in a write-up for this (fictitious) experiment instead of writing up the **actual** experiment that they performed. Please save yourself some embarrassment and do not be one of those students!*

Rubric

Lab write-ups throughout the year will be graded according to a rubric similar to the following.

Items that are ~~crossed out~~ do not apply to this write-up.

~~Notes (recorded *during* the experiment)~~

- ☐ ☐ ~~notes included (elsewhere in notebook)~~
- ☐ ☐ ~~notes are on separate page(s) from the report~~

Title, Objective, *etc.*

- ☐ ☐ title included in report
- ☐ ☐ ~~lab partner(s) listed~~
- ☐ ☐ objective included in report
- ☐ ☐ title & objective both correctly describe purpose of experiment

Experimental Design

- ☐ ☐ section included in report
- ☐ ☐ explains basis for experimental design ~~(using equations where necessary)~~
- ☐ ☐ ~~explains which measurements need to be taken and why~~

Procedure

- ☐ ☐ section included in report
- ☐ ☐ all significant materials explicitly listed (either separately or mentioned within steps)
- ☐ ☐ ~~describes what was done to take each measurement, including equipment used~~
- ☐ ☐ includes *labeled* sketch of apparatus
- ☐ ☐ 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) and relevant qualitative observations
- ☐ ☐ ~~gives uncertainty for each measured quantity~~

Analysis

- ☐ ☐ section included in report
- ☐ ☐ includes 1–2 sentence discussion of the results
- ☐ ☐ ~~calculations & graph(s) shown~~
- ☐ ☐ ~~calculations readable and in logical order~~
- ☐ ☐ ~~calculations are correct~~
- ☐ ☐ ~~uncertainty calculations shown~~
- ☐ ☐ lists & explains at least 2 sources of uncertainty (*Not mistakes!*)

Conclusions

- ☐ ☐ section included in report
- ☐ ☐ gives 1–2 sentence summary of results
- ☐ ☐ suggests improvements to design/ procedure and/or follow-up experiments

Format, *etc.*

- ☐ ☐ sections in correct order
- ☐ ☐ hand-written in lab notebook, starting on a new page

1–2 days late: −1 point
> 2 days late but < 2 weeks late: −4 points
≥ 2 weeks late: −8 points

Points: _____

Score: _____ / 50

Percentage: _____ %

Points	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15
Score	50	49	47	46	45	44	42	41	40	39	37	36	35	34	32	31
%	100	98	94	92	90	88	84	82	80	78	74	72	70	68	64	62
Points		14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Score		30	29	27	25	24	22	20	19	17	15	13	10	7	4	0
%		60	58	54	50	48	44	40	38	34	30	26	20	14	8	0