# AP PHYSICS C
## Summer Assignment

You can access an online version of the textbook here. Stop by room 403 before final exams to introduce yourself and pick up a physical copy of the book if you prefer it to using a pdf.

All parts of this assignment are due at the beginning of the first day of class, or you will earn a zero. Part 2 will be graded for completeness; the other parts will be graded for correctness.

NOTE: You must ***show all of your work*** to receive full credit (formulae, substitutions, unit conversions, answers, units, graphs, etc.)

**PART 1: Review of Motion in 1-D**

Read Ch. 1-2, and do the problems listed below, starting on p.32 in the Problems section.

| Problem | Answer |
|---|---|
| 2 | 1.75m/s, 2.14m/s, graphs |
| 30 | 2.5s, graphs |
| 54 | 12.3m/s, graphs |
| 63 | 2.34m |
| 69 | 100m |
| 74 | 1.29s |
| 78 | crash, red: 0m/s, green: 10m/s |
| 100 | 17s, 290m |

We'll discuss this material the first few class periods and then dive into derivatives. You can expect a test on 1-D motion within a week of returning to school.

**PART 2: Unit Vector Notation and Motion in 2-D**

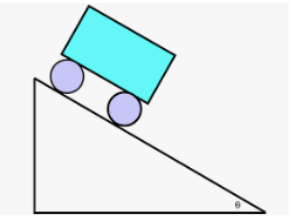
1. Read 3.1-3.2. Some of this might be new to you, but it is relevant to our second unit.
2. Answer the following questions in writing.
    a. *What do i-hat, j-hat, and k-hat represent?*
    b. *What is the advantage of using unit vector notation instead of magnitude-angle notation?*
3. Read 4.1-4.4. You will learn the calculus in class, but you need to arrive well-versed in projectiles.
4. Do the problems listed below, starting on p.84 in the Problems section of Ch. 4. Put them on a separate piece of paper from your Ch. 2 work.

| Problem | Answer |
|---|---|
| 3 | -2**i**+6**j**-10**k** |
| 21 | 0.18m, 1.9m |
| 28 | 51.8m, 27.4 m/s, 67.5m |
| 30 | 5.8m/s |
| 43 | 11m, 23m, 17m/s, -63° |
| 97 | 0.062s, 482m/s |

# AP PHYSICS C
## Summer Assignment

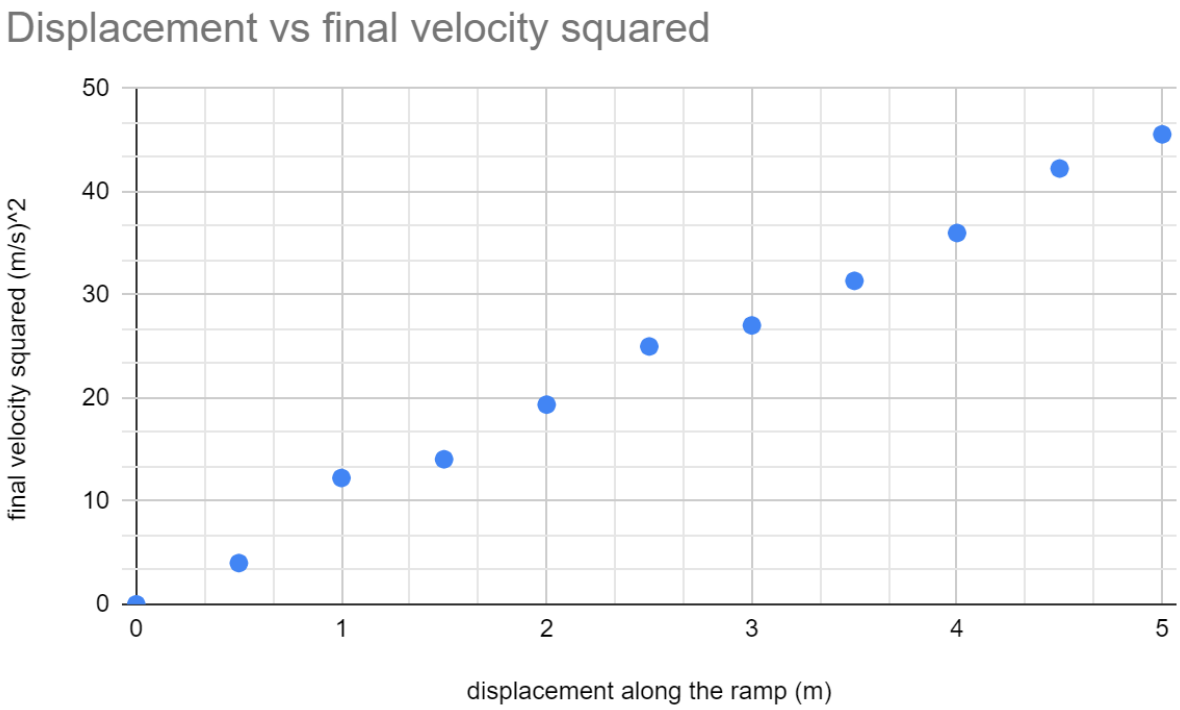
**PART 3: Interpreting data**

As illustrated in the diagram, a toy car rolls down an incline of 30° above the horizontal.


(Diagram is not to scale.)

You keep the angle of incline constant and release the car from rest at several different locations on the ramp. You measure the displacement and the velocity of the car when it reaches the bottom of the ramp.

The graph below is a linearization of the data. Scientists and engineers linearize data by squaring (or square rooting) measurements and then graphing those values. Doing so allows us to more easily quantify patterns in data without sacrificing accuracy.




1. Draw a best-fit trendline on the graph.

2. Use your trendline to determine an experimental value for the acceleration of the toy car.
   a. Determine the equation of the trendline. Show all of your work, or indicate that you used Desmos or a graphing calculator.
   b. What single kinematics equation best represents the knowns and unknowns here?
   c. Relate each term in that kinematics equation to each term in y=mx+b.
   d. Solve for the acceleration.

3. Theoretically, the acceleration of the car should have been 4.9m/s$^2$. Give two plausible reasons for the discrepancy between this value and the one you determined in question #2d.

# AP PHYSICS C
## Summer Assignment

**PART 4: Ranking Tasks**

Compelling arguments in any discipline make a claim, provide supporting evidence, and articulate the reasoning linking the claim to the evidence. In this part of the assignment, you will construct a series of such arguments. Your work will be evaluated on a 0-6 point scale per the rubric below.

Rank each scenario based on the criteria given (i.e. make a claim). Provide a written justification of your rankings, including any ties. Include references to the information given in the problem statement and/or diagrams (i.e. evidence) and make explicit connections to relevant physics principles (i.e. reasoning).

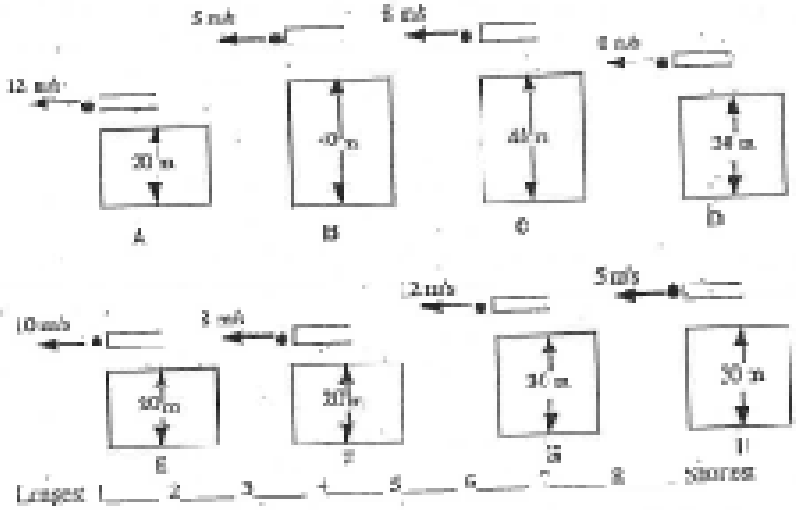
| Component | Level 1 (0 pts) | Level 2 (1 pt) | Level 3 (2 pts) |
|---|---|---|---|
| *Claim*: a response to the question asked or the problem posed. | Does not make a claim, or makes an inaccurate claim. | Makes an accurate but incomplete claim. | Makes an accurate and complete claim. |
| *Evidence*: use of data to support the claim. | Does not provide evidence, or provides inappropriate or irrelevant data in support of the claim. | Provides appropriate, but insufficient evidence to support the claim. May include some inappropriate evidence. | Provides appropriate and sufficient evidence to support the claim. |
| *Reasoning*: use of scientific principles to show why data count as evidence to support the claim. | Does not provide reasoning, or provides reasoning that does not link evidence to the claim. | Provides reasoning but repeats the evidence and/or includes insufficient reference(s) to relevant scientific principles. | Provides reasoning that clearly and logically links evidence to the claim. Includes appropriate and sufficient references to scientific principles. |

EXAMPLE

Title: Shoot Time to Hit Ground [40]

The eight figures below show rifles that are being fired horizontally, i.e., straight out, off platforms. The bullets used in the rifles are all identical, but the rifles propel the bullets at different speeds. The specific speed of each bullet and the height of each platform is given. All of the bullets miss the targets and hit the ground.

Rank these bullets, from longest to shortest, on the basis of how long it takes a bullet to hit the ground. That is, put first the bullet that will take the longest time from being fired to hitting the ground, and put last the bullet that will have the shortest time.




CLAIM: BC TIE; D, G TIE; A, C, F TIE

Justify your rankings.

EVIDENCE: B & C START FROM AN ELEVATION OF 40 M, THE HIGHEST OF THE CLIFFS DEPICTED. D, G, & H ARE RELEASED FROM 30 M-TALL CLIFFS. A, F, & F ARE ALL FALLING FROM 30 M CLIFFS.

REASONING: THE ONLY FACTOR THAT AFFECTS TIME IN THE AIR FOR HORIZONTALLY LAUNCHED PROJECTILES IS INITIAL ELEVATION. HORIZONTAL VELOCITY AFFECTS ONLY HORIZONTAL MOTION, IE THE RANGE. SINCE ALL HAVE IN THE VERTICAL VELOCITY OF ZERO & A VERTICAL ACCELERATION DUE TO GRAVITY, HIGHER VERTICAL DISPLACEMENT REQUIRES MORE TIME TO FALL.

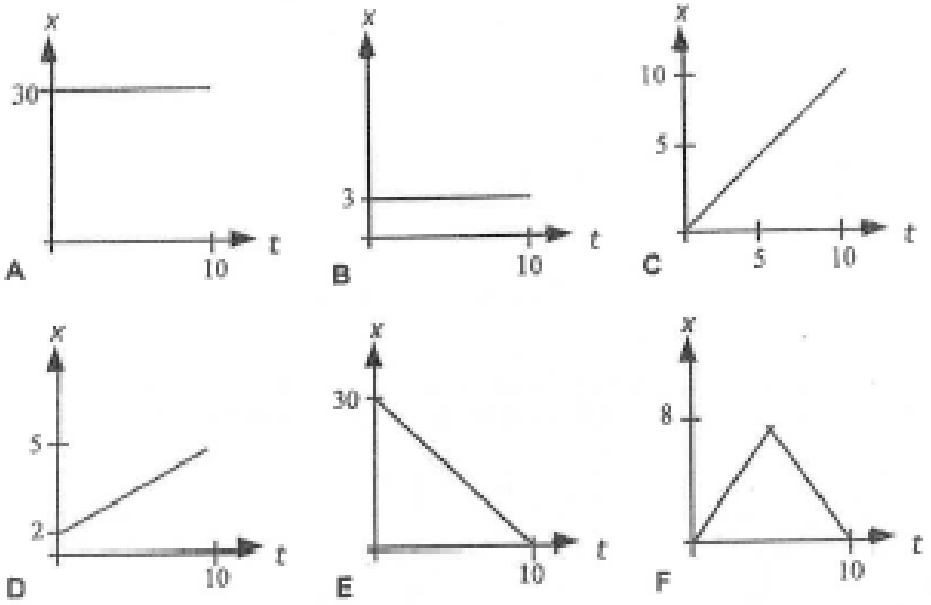
$\Delta x = v_0 t + \frac{1}{2} a t^2$

$\therefore \Delta x \propto t$

# AP PHYSICS C
## Summer Assignment

### Position Time Graphs—Average Speed [19]

In the position vs. time graphs below, all the times are in seconds (s), and all the positions are in meters (m). Rank these graphs on the basis of which graph indicates the greatest average speed, where the average speed is calculated from the beginning to the end of motion. Give the highest rank to the one(s) with the greatest average speed, and give the lowest rank to the one(s) indicating the least average speed. If two graphs indicate the same average speed, give them the same rank.




Greatest 1_____ 2_____ 3_____ 4_____ 5_____ 6_____ Least

Or, none of these are moving at all. _____

Or, the average speed is the same for all of these. _____

Please carefully explain your reasoning.

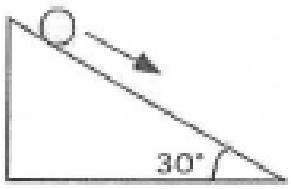
# AP PHYSICS C
## Summer Assignment

### Objects in Different Situations—Accelerations [5]

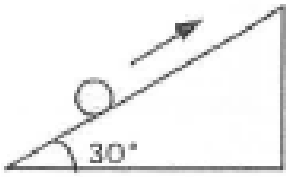
The following objects are sitting, falling, rolling, swinging, or just going in circles, as indicated in the different situations below. Each has an acceleration in some direction or another. You are to rank them from greatest to least on the basis of the magnitude of acceleration. If two or more objects have the same acceleration, rank them the same.

**A.** Object dropped from the top of a building.

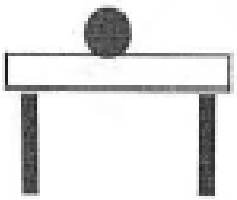
**B.** Object rolling from rest down an inclined plane.



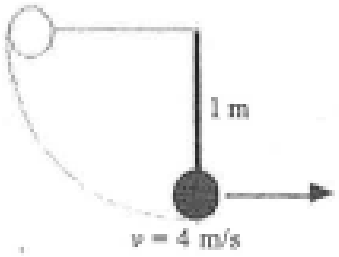

**C.** Object rolling up a inclined plane after being given an initial velocity of 4 m/s.



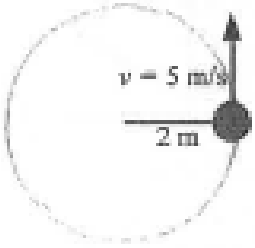

**D.** Object sitting on table top motionless.



**E.** Object attached to a strin at the bottom of the swing.




**F.** Object traveling in a circle with constant speed




Greatest 1____ 2____ 3____ 4____ 5____ 6____ Least

Or, all of these have the same magnitude of acceleration._____

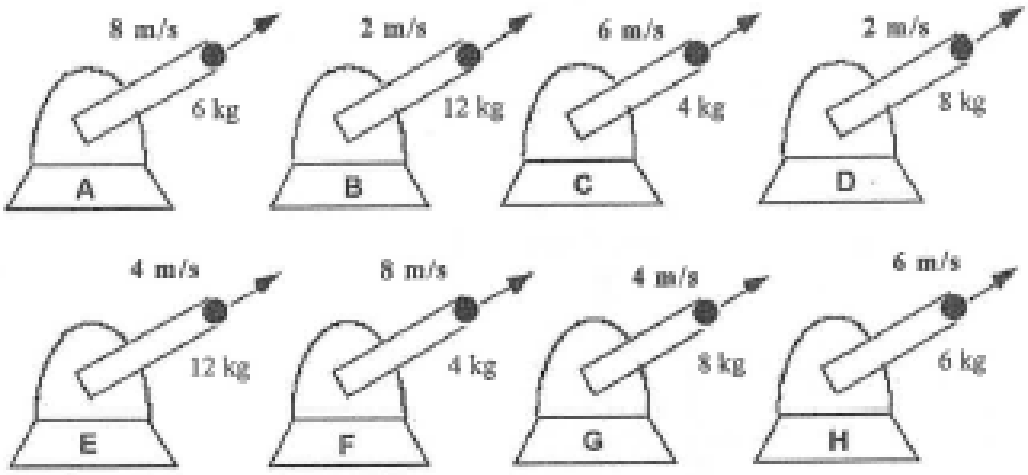
Please carefully explain your reasoning.

# AP PHYSICS C
## Summer Assignment

### Cannon Shots—Acceleration at the Top [52]

The figures below depict eight cannons shooting shells into the air. All of the cannons are aimed at the same angle of 35 degrees. All of the cannons are identical. The shells are all the same size and shape, but the masses of the shells, as well as their speeds as they leave the cannons, are different. The values of these variables are specified in the figures.

Rank these situations from highest to lowest on the basis of the acceleration at the highest point reached by the shells. (We assume for this situation that the effect of air resistance can be ignored.)




Highest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ Lowest

Or, all of the shells have the same (nonzero) acceleration at the top. _____

Or, all of the shells have the zero acceleration at the top. _____

Please carefully explain your reasoning.

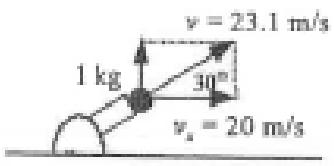
# AP PHYSICS C
## Summer Assignment

### Projectile—Horizontal Distance [54]

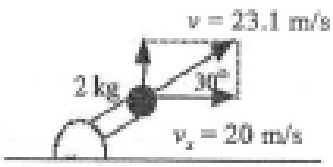
The pictures below depict cannonballs of two different masses projected upward and forward. The cannonballs are projected at various angles above the horizontal, but all are projected with the same horizontal component of velocity.

Rank according to the horizontal distance traveled by the balls.

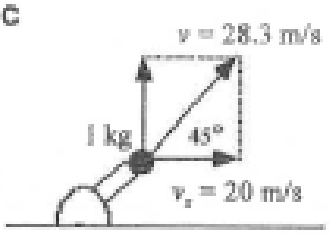
A



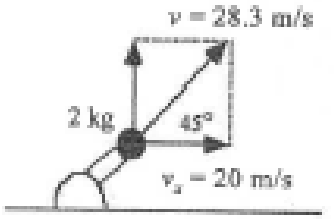

B



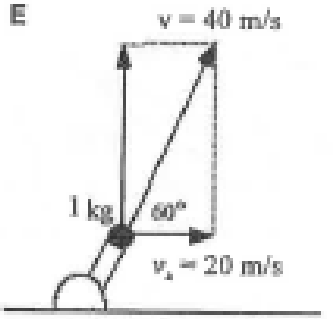

C



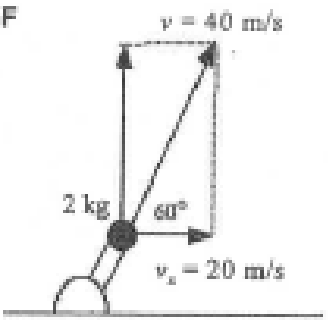

D




E




F




Largest 1_____ 2_____ 3_____ 4_____ 5_____ 6_____ Smallest

All distances traveled are the same. _____

Please carefully explain your reasoning.

# AP PHYSICS C
## Summer Assignment

**PART 5: Filling in some gaps**

If AP Physics 1 was not your first-year physics course, you have no background in rotation or simple harmonic motion. Since AP Physics C assumes students have a working knowledge of these topics, you will need to build that over the summer.

If you are such a person, email me and I will share slides and practice problems on these topics with you. Email me again after you try them, and I will send you the solutions.

I would also recommend that you explore the following resources:

- Flipping Physics on YouTube https://www.youtube.com/user/flippingphysics/videos
- Khan Academy
    - https://www.khanacademy.org/science/physics/torque-angular-momentum
    - https://www.khanacademy.org/science/ap-physics-1/simple-harmonic-motion-ap
- The Physics Classroom
    - https://www.physicsclassroom.com/Physics-Interactives/Balance-and-Rotation
    - https://www.physicsclassroom.com/class/waves/Lesson-0/Motion-of-a-Mass-on-a-Spring
    - https://www.physicsclassroom.com/class/waves/Lesson-0/Pendulum-Motion

YOU ONLY NEED TO DO **Part 5** IF AP PHYSICS 1 WAS NOT YOUR FIRST-YEAR PHYSICS COURSE.