

AP Physics C: Summer Assignment

Welcome to AP Physics C!

AP Physics C is one of the most challenging and most rewarding classes a high school student can take and I am glad to see you are considering taking this course. AP Physics C: Mechanics covers Kinematics, Newton's Laws of Motion, Work, Energy, Power, Systems of Particles and Linear Momentum, Rotation, Oscillations, Gravitation and AP Physics C: Electricity & Magnetism covers Electrostatics, Conductors, Capacitors, Dielectrics, Electric Circuits, Magnetic Fields, and Electromagnetism. Studying physics with calculus certainly can be difficult but with hard work you can be laying the foundation to a great career in science, engineering, mathematics, or anything else that requires a lot of critical thinking. If you think that AP Physics C is for you, then complete the following summer assignment and hand it in on the first day of school. On the second day of school there will be an entrance exam to make sure that AP Physics C is a good fit for you this year. The entrance exam will make sure you have the necessary math background to succeed in AP Physics C. Students that score a 90% or above on this exam will possess the required skills to continue in AP Physics C, while students that score lower might benefit from having an additional year of math or switching to AP Physics 1 or 2, both great courses that lay a foundation for describing the rules of motion with algebra. I'm looking forward to meeting you on the first day of school and be sure to check out the helpful links throughout this assignment to get refreshers with the math skills and watch the necessary video for the graphing portion of the assignment.

Sincerely,
Dr. Jones

Part 1: Goals for AP Physics

Watch the [video in this link](#) showing the different topics covered in AP Physics C.

- 1) What AP Science classes have you taken in the past?
- 2) What are your goals for AP Physics C?
- 3) What topic are you most looking forward to in AP Physics C: Mechanics?
- 4) What topic are you most looking forward to in AP Physics C: Electricity & Magnetism?
- 5) Have a great time with the summer assignment! Show all necessary work in the space provided. Answers without work will be graded as zeros. Draw a stick figure in the space below to confirm that you will show all of your work.

Part 2: Measuring Skills

A ruler will be required for this section of the summer assignment. An AP Physics C student should have no problem converting units and measuring objects. Students that can not do common conversions from centimeters to meters in their head are not prepared for AP Physics C. For now, ignore the uncertainty of your measurements. We'll handle that in class.

Section I: Measuring a Small Object

- 1) Find a small object. Record your object: _____
- 2) Measure the height of your object in meters. Record this height to the right: _____
- 3) Convert your measurement to cm.
- 4) Convert your measurement to μm .
- 5) Convert your measurement to mm.
- 6) Convert your measurement to feet.
- 7) Convert your measurement to miles.
- 8) Estimate the volume of your object.

Section II: Measuring a Large Object

- 1) Find a large object and take a picture of it. Record your object: _____
- 2) Measure the height of your object in meters. Record this height to the right: _____
- 3) Convert your measurement to cm.
- 4) Convert your measurement to μm .
- 5) Convert your measurement to mm.
- 6) Convert your measurement to feet.
- 7) Convert your measurement to miles.
- 8) Estimate the volume of your object.

Part 3: Algebraic Skills

An AP Physics C student should be so comfortable with algebra and pre-calculus that the following questions are routine. If the following types of problems prove to be too difficult on the entrance exam then AP Physics 1, 2, or a different course will be more appropriate for you to take during the upcoming school year.

Section I

The equation relating the variables T_s , m , and k is shown below.

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

- 1) As k approaches infinity, what happens to T_s ? Explain.

Example of a Superior Answer: As k gets larger and larger and approaches infinity, T_s gets smaller and smaller and approaches zero. T_s and k have an inverse square relationship, and the square root of $1/\infty$ is zero.

- 2) As m approaches infinity, what happens to T_s ? Explain.

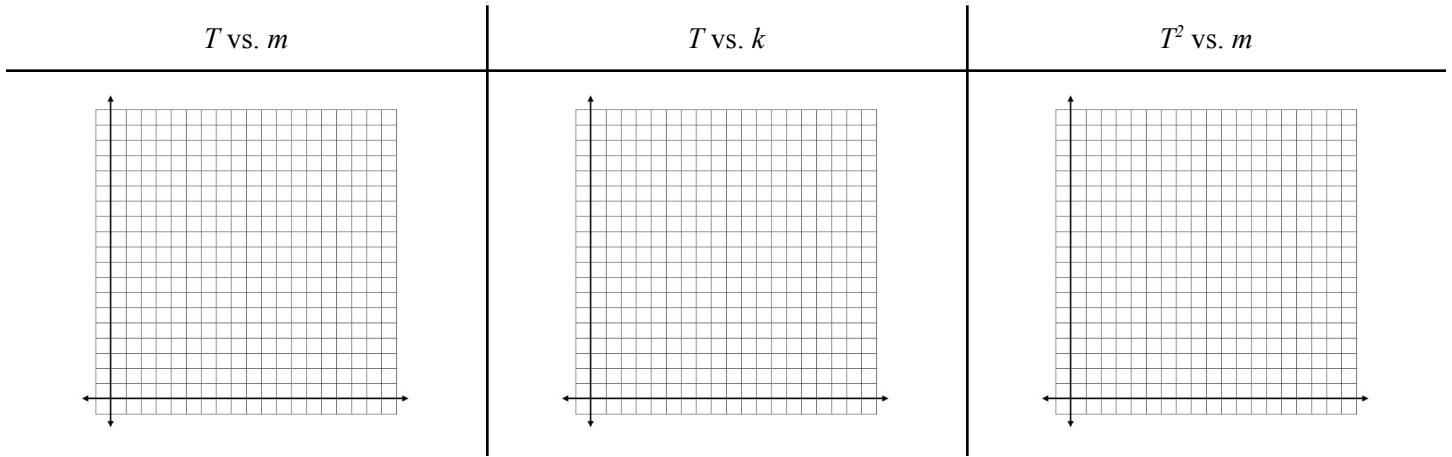
- 3) If m is doubled and T_s remains constant, what happens to k ? Explain.

If m is doubled and T_s remains constant, then k must have doubled as well. In algebra, whatever you do to one side you must do to the other. If T_s is remaining constant, than it is essentially being multiplied by 1. In order to have one on the other side, the 2 in front of the m must be canceled out by a 2 in front of the k . In the equation below, you can see that if m is doubled and k is doubled then T_s remains unchanged.

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

- 4) If m is tripled and k remains constant, what happens to T_s ? Explain.

- 5) On the graphs below, sketch¹ the following graphs to show the relationships. Label each axes with the correct variable and units. When a graph is written in the form y vs. x , the first term should go on the y -axis.



- 6) Rearrange the equation above to solve for k .

- 7) Rearrange the equation above to solve for m .

Section II

The equation relating the variables F_G , m_1 , m_2 , G and r is shown below.

$$|\vec{F}_G| = \frac{Gm_1m_2}{r^2}$$

- 1) As r approaches infinity, what happens to F_G ? Explain.

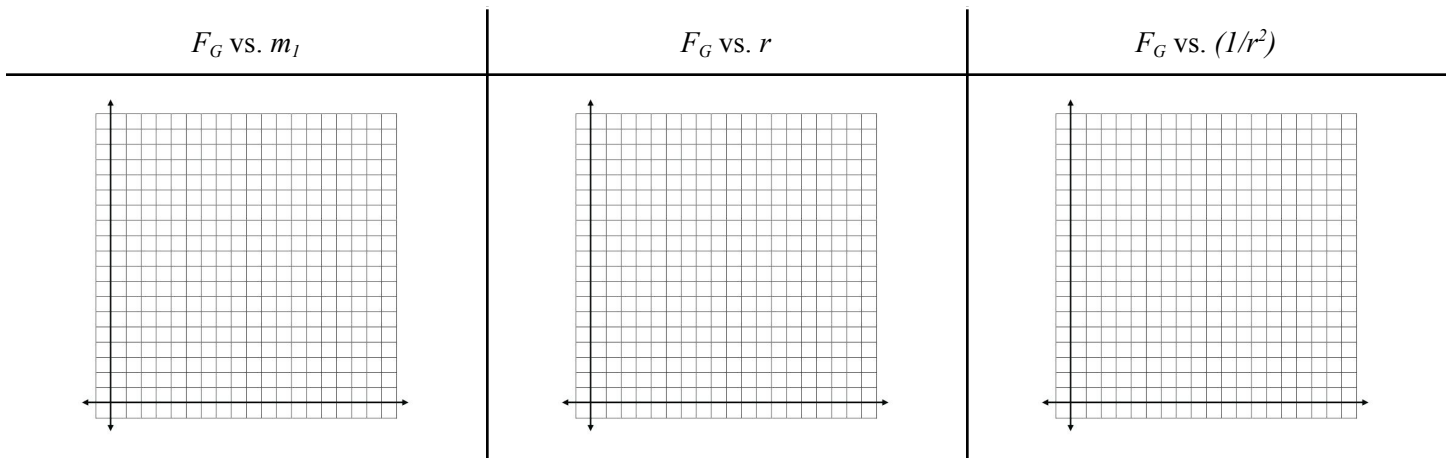
¹ A sketch means that you should not plot exact values, but rather just a line or curve to show the relationship between two variables.

2) As m_1 approaches infinity, what happens to F_G ? Explain.

3) If m_1 is doubled while m_2 and r remain constant, what happens to F_G ? Explain.

4) If m_1 is tripled, m_2 is tripled, and r is tripled, what happens to F_G ? Explain.

5) On the graphs below, sketch the following graphs to show the relationships. Label each axes with the correct variable and units. When a graph is written in the form y vs. x , the first term should go on the y -axis.



6) Rearrange the equation above to solve for r .

7) Rearrange the equation above to solve for m_2 .

Section III

The equations relating K , m , v , and p are shown below.

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

$$p = mv$$

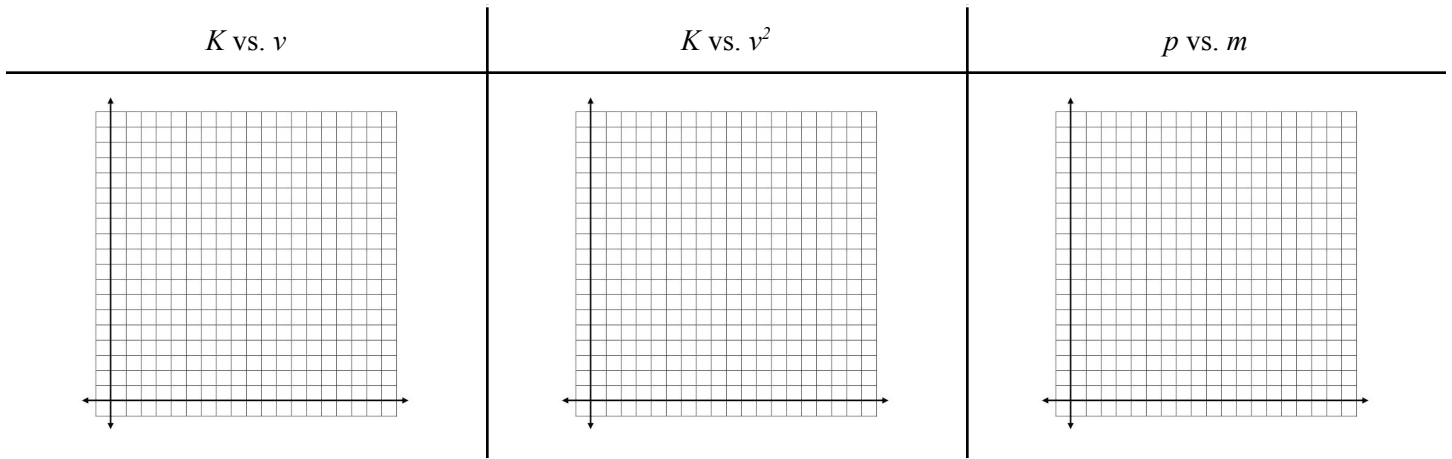
1) As m approaches infinity, what happens to K ?

2) If v is tripled and m remains constant, what happens to p ?

3) If v is tripled and m remains constant, what happens to K ?

4) Combine the two equations to solve for K in terms of only p and m .

- 5) On the graphs below, sketch the following graphs to show the relationships. Label each axes with the correct variable and units. When a graph is written in the form y vs. x , the first term should go on the y -axis.



Section IV

The equation relating the variables F_E , q_1 , q_2 , ϵ_0 and r is shown below.

$$|\vec{F}_E| = \frac{1}{4\pi\epsilon_0} \left| \frac{q_1 q_2}{r^2} \right|$$

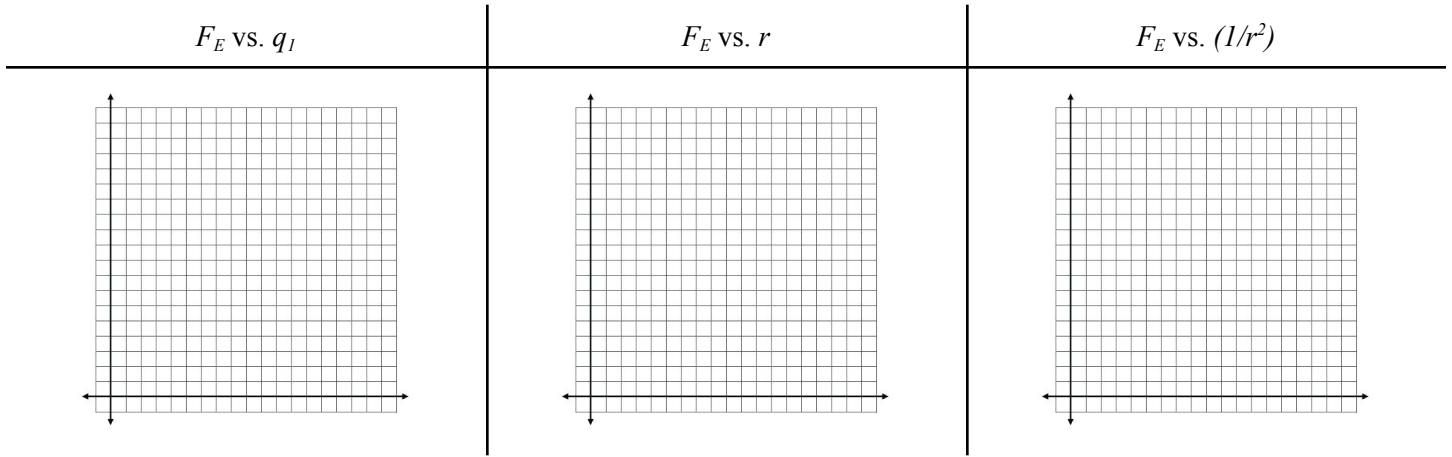
- 1) As r approaches infinity, what happens to F_E ? Explain.

- 2) As q_1 approaches infinity, what happens to F_E ? Explain.

- 3) If q_1 is doubled and r remains constant, what happens to F_E ? Explain.

4) If q_1 is doubled, q_2 remains the same, and r is tripled, what happens to F_E ? Explain.

5) On the graphs below, sketch the following graphs to show the relationships. Label each axes with the correct variable and units. When a graph is written in the form y vs. x , the first term should go on the y -axis.



6) Rearrange the equation above to solve for r .

7) Rearrange the equation above to solve for q_2 .

Part 4: Average Rate of Change

For each of the following problems, find the average rate of change of the function over the given interval.

1) $f(x) = x^2 - x - 1$ from $x = 0$ to $x = 10$

2) $f(x) = x^2 - x - 1$ from $x = 10$ to $x = 20$

3) $f(x) = x^2 - x - 1$ from $x = 0$ to $x = 20$

Explain why your answer to (3) makes sense when compared to your answers from (1) and (2).

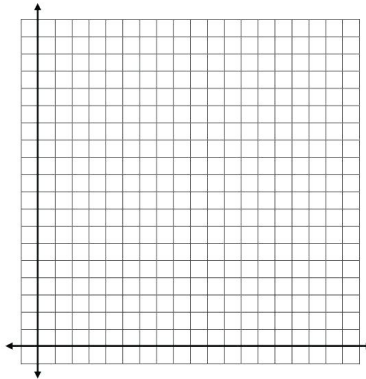
4) $f(x) = \frac{1}{x}$ from $x = 0.25$ to $x = 0.50$

5) $f(x) = \frac{1}{x}$ from $x = 0.50$ to $x = 0.75$

6) $f(x) = \frac{1}{x}$ from $x = 0.75$ to $x = 1.00$

7) $f(x) = \frac{1}{x}$ from $x = 500$ to $x = 500.25$

8) Sketch a graph of the function $f(x) = \frac{1}{x}$ on the graph below



9) Explain how your graph relates to your answers from questions 4 through 7

10) A New Jersey State trooper accused a driver of speeding while on Interstate-95, but the driver refutes this claim and demands a hearing. The speed limit on Interstate-95 is 65 miles-per-hour. At the hearing, the judge is presented with three photographs as evidence:

- The first photograph shows the driver's car stopped at a rest station at 8:00 PM
- The second photograph shows the driver's car stopped at the same rest station at 8:10 PM
- The third photograph shows the driver's car passing through an EZ Pass toll booth at 8:30 PM. The toll booth is 26.3 miles down the road from the rest station.

Is the driver guilty of speeding? Explain

11) $f(x) = 2x^2 - 2x - 1$ from $x = 5$ to $x = 10$

12) $f(x) = 2x^2 - 2x - 1$ from $x = 10$ to $x = 15$

13) $f(x) = 2x^2 - 2x - 1$ from $x = 15$ to $x = 20$

Part 5: Limits to Infinity

1) $\lim_{x \rightarrow -\infty} (x^3 - 3x + 2)$

2) $\lim_{x \rightarrow \infty} \frac{-x + 2}{x^2 + x + 1}$

3) Explain what happens to dB as r gets larger. $d\vec{B} = \frac{\mu_0 I d\vec{L} \times \vec{r}}{r^3}$

4) $\lim_{x \rightarrow \infty} (x^5 - 3x^3 + 3x - 1)$

5) $\lim_{x \rightarrow \infty} \frac{x}{x+3}$

6) Explain what happens to U_C as Q gets larger $U_C = \frac{1}{2}Q\Delta V = \frac{1}{2}C(\Delta V)^2$

7) Explain what happens to U_E as r gets larger $U_E = qV = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r}$

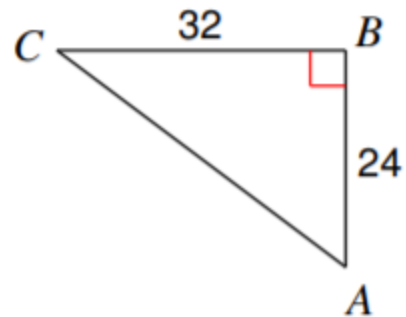
Part 6: Trigonometry

Trigonometry needs to be a foundational skill in AP Physics C.

- 1) Answer the following regarding the triangle to the right, with angles A, B, and C.

$\tan(A) = \underline{\hspace{2cm}}$ $\cos(A) = \underline{\hspace{2cm}}$ $\sin(A) = \underline{\hspace{2cm}}$

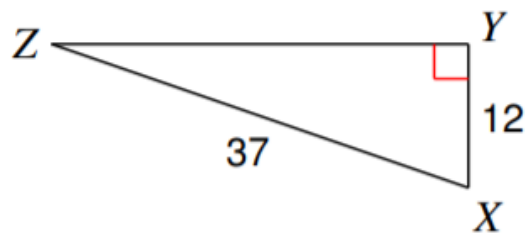
$\tan(C) = \underline{\hspace{2cm}}$ $\cos(C) = \underline{\hspace{2cm}}$ $\sin(C) = \underline{\hspace{2cm}}$



- 2) Answer the following regarding the triangle to the right, with angles X, Y, and Z.

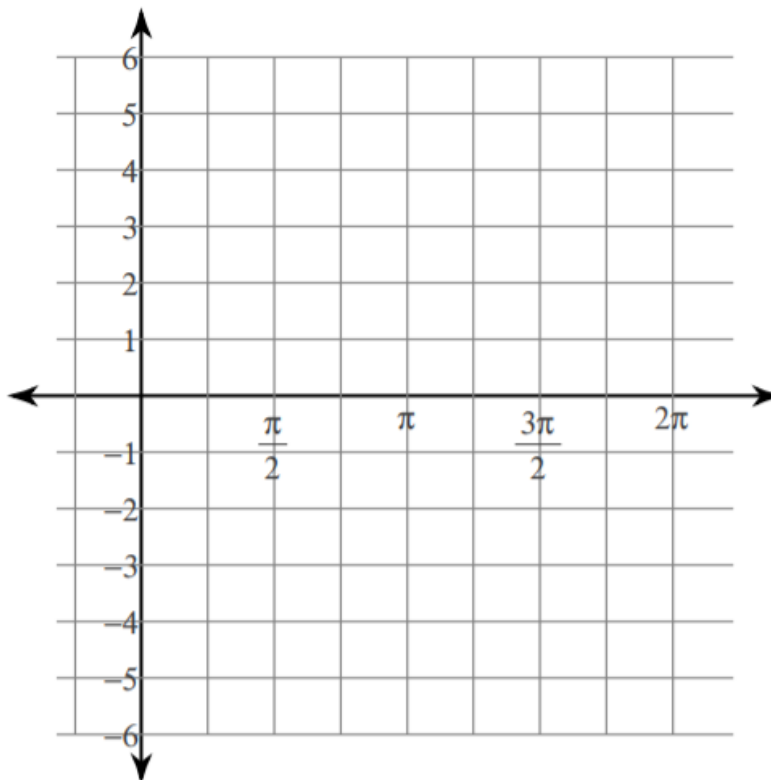
$\tan(X) = \underline{\hspace{2cm}}$ $\cos(X) = \underline{\hspace{2cm}}$ $\sin(X) = \underline{\hspace{2cm}}$

$\tan(Z) = \underline{\hspace{2cm}}$ $\cos(Z) = \underline{\hspace{2cm}}$ $\sin(Z) = \underline{\hspace{2cm}}$



- 3) Graph the following function on the graph below.

$$f(x) = 5 \sin\left(2x + \frac{\pi}{2}\right)$$

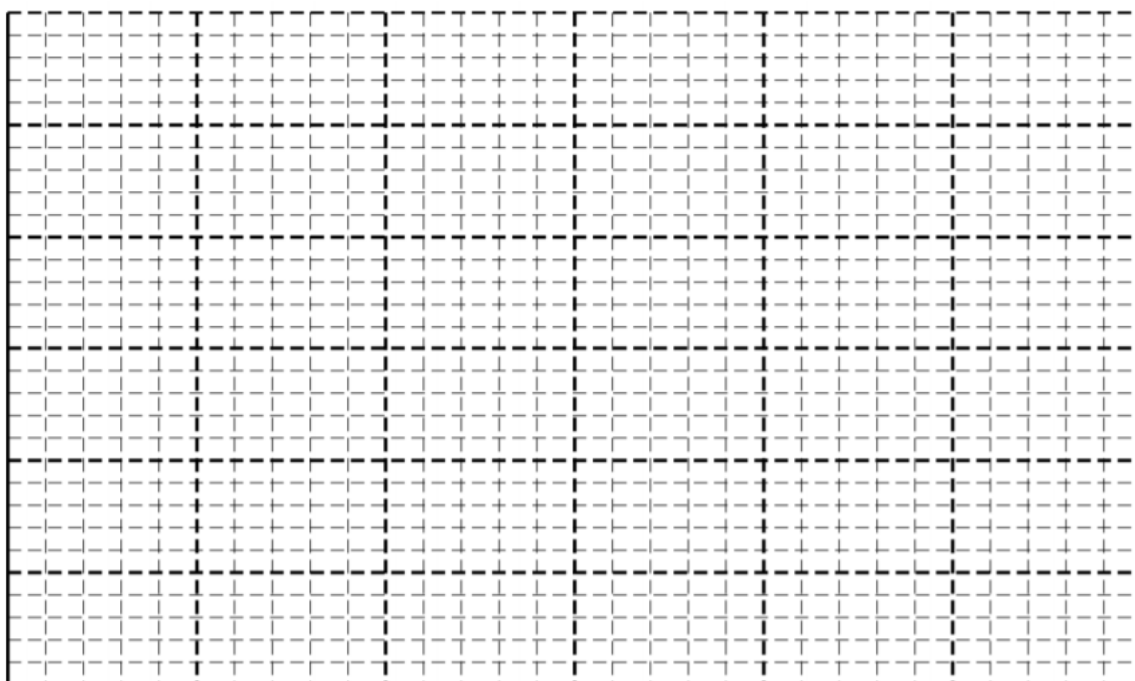
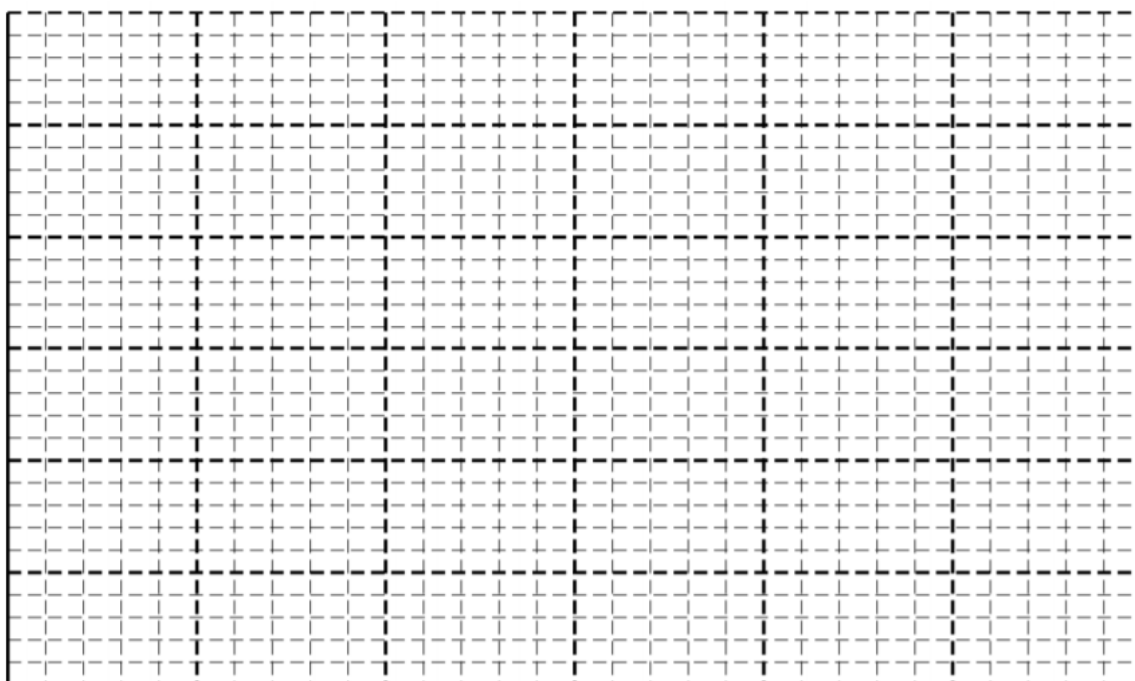


Part 7: Graphing Skills

The [video in this link](#) shows a low friction puck that is gliding over the floor and filmed by a camera attached to the ceiling. Your task is to collect data for the puck's position as a function of time. The video starts at 0 seconds which corresponds to Frame 0. If you pause a YouTube video, you can advance the video by one frame by pressing the 'period' button and go back one frame by pressing the 'comma' button. You must collect 20 pieces of data for the puck's position. You do not have to record the uncertainty of the measurements, we will learn more about uncertainty throughout AP Physics C. You must be logged in to your htps.us account to view the video.

Frame	Time (s)	Horizontal Position (m)	Vertical Position (m)

- 1) On the following page, create two hand-drawn graphs that show the puck's **Horizontal Position vs. Time** and the puck's **Vertical Position vs. Time**. When a graph is written as y vs. x the first term should be plotted on the y -axis and the second term on the x -axis.
- 2) Each axes needs to be correctly labeled with units.
- 3) Each of the graphs needs to be scaled correctly, with each grid representing the same value.
- 4) Each graph needs a linear trendline drawn with a ruler to show the trend of the data.
- 5) Making college level graphs is a skill that an AP Physics C student should find easy and is a required skill to enter this course.



- 6) Determine the slope of your trendline on the *Horizontal Position vs. Time* graph. Do not use data points in your calculation, only points from the trendline. Include units in your trendline.

- 7) Express the *Horizontal Position vs. Time* trendline in slope-intercept form.

- 8) Determine the slope of your trendline on the *Vertical Position vs. Time* graph. Do not use data points in your calculation, only points from the trendline. Include units in your trendline.

- 9) Express the *Vertical Position vs. Time* trendline in slope-intercept form.

- 10) In a well written paragraph², explain the significance of the slopes of the two graphs and what information you can glean about the motion of the puck.

² AP Physics students are asked to give a paragraph-length response so that they may demonstrate their ability to communicate their understanding of a physical situation in a reasoned, expository analysis. A student's response should be a coherent, organized, and sequential description of the analysis of a situation. The response should argue from evidence, cite physical principles, and clearly present the student's thinking to the reader. The presentation should not include extraneous information. It should make sense on the first reading.