

AP Physics 1 – Summer Assignment 2026

Before you do anything Print the assignment!!!!

Print out the assignment and answer the questions in the space provided for each - do NOT type into the document (you will mess up spacing of diagrams if you do) - you will want the document open on a computer to follow links while you work. If you need more space than is provided, use loose leaf. Make sure you label your work on loose leaf with the question number. Turn the assignment in with the printed assignment in front and any loose leaf in order at the back.

Welcome to AP Physics. Here is your summer assignment - due the first day of class in September. Physics requires strong math skills – particularly in algebra and trigonometry. Many problems in Physics require the application of principles that you have studied in your math courses. This packet reviews mathematical concepts with which you should already be familiar. If you don't remember the concept well (or at all) you need to find some outside resource to help you – a book, a friend, the internet.

The packet will be graded – it will be your first grade in AP Physics – and will also provide a review of some of the material from the past year, or an introduction to that material if you did not take Physics yet. This is material that you will need to understand to start your work in AP Physics. The more effort you put into this assignment, the better prepared you will be for class. This is a long assignment – if you leave it until the last week (or day) of Summer Break, you will be overwhelmed and you will not learn the material. You should be working on it a bit at a time the whole summer.

Some things to know about AP Physics 1:

AP Physics is not just plugging in numbers. The course focuses more on concepts. Almost every problem is new and different – including the ones on the actual AP exam. The problems are about applying the concepts to the problem at hand, not being able to follow a prescribed set of steps for a problem.

A review book is helpful – there are many good ones available. For students who have not taken Regents Level Physics, you are advised to buy a general review book (Barrons Physics Review is a good book, but not the only one) and do some reading. If you are looking for a review book to help you with the course during the year there are several good AP Physics 1 review books out there. (The Princeton Review AP Physics 1 Exam, 5 Steps to a 5 AP Physics 1: Algebra - Based by Greg Jacobs are two that come to mind.)

There are a lot of good websites for help with Physics concepts –

prettygoodphysics, thephysicsclassroom, ColoradoPhET, MIT open courses,

Khan Academy, AP central, Flippin' Physics,

Look them over during the summer. (You will be using some of these for this assignment.)

AP Physics 1 is very heavy on explanation – that is, not just applying math concepts, but explaining, in depth, the concepts that underlie a problem and the reasoning behind your solution. Yes, there is writing in Physics. Einstein wrote papers, Dr. Michio Kaku writes books, and you, too, will write. Review the alphabet. You will find it useful. **For calculations:**

Many times in AP Physics you will be required to show all of your calculation or derivations steps. You have to show calculations in a logical, orderly manner (neatness counts here – a whole lot, in fact). The idea is that your calculations can be easily followed by another reader, researcher, or – more to the point for you – an AP Exam grader.

It does not matter if you, personally, do not like to show steps. It does not matter if you, personally, are not the neatest person in the world. Calculations, like writing, are a communication – both with another person and with your future self when you look over your work. Poor logic sequence in calculation or leaving out steps necessary for someone to follow the flow of the problem is the same as mixing up tenses and skipping words in writing – it makes what you are trying to say with your calculation incomprehensible. *One more time – it matters, no kidding, get used to it.*

For any work that requires calculations, you need to show all of your work- that means

- Show the equation or equations that you are using
- Show the steps using the starting equations to derive an overall equation for the situation (often, this will be where you stop - many derivations are about deriving the equation and using it for prediction, not actually solving with numbers)
- Show the plug in (numbers and units)
- Show the final answer with units

For explanation:

Some of these problems require explanation rather than calculation. *When explanation is required you need to answer the questions completely using correct sentence structure, grammar, and spelling, in your own words. Giving a complete answer means justifying your answer.* One word answers are not acceptable. Incomplete answers are not acceptable. You may type your answers or write them out, but they must be on separate paper. Remember – you are an AP Physics student – you need to be able to work independently. If you don't know what a word means (or what it means in terms of Physics – sometimes the common use of the word and the scientific use are not the same) look it up. If your first search for concepts to help you answer a question doesn't work, keep looking. If the video makes use of concepts with which you are unfamiliar, look them up.

Here is some guidance on what this means:

What does “show your work” mean?

As a student, you are probably told to “show your work” many times a day - but why do you need to show your work and what, exactly, do you need to do to “show your work”?

Why Show your work?

Even though it might seem like the teacher is just trying to annoy you, there are some important reasons to show your work!

- On homework, it can help the teacher see if you understand the work. If you get the right answer, great! But sometimes you get the right answer, or close to it, even if your logic is off - in other words, you got a bit lucky. Seeing the work and

not just the answer can help the teacher figure this out and clarify the concepts for you - this way you aren't continuing to rely on misconceptions as you work out other problems - when you might not be so lucky.

- On exams and quizzes you are trying to show the instructor what you know. Showing work helps you to do that - maybe you are working through a long problem and you make one error - that error may mean your final answer is incorrect, but your teacher can see that you understood a lot of the problem - and can give you points for that.

Okay, so that is WHY you show work - but HOW do you show work? What, exactly, do you need to do?

Let's start by looking at a problem:

A car is traveling at 35 m/s when the driver notices a speed limit sign for 20 m/s and a police car parked further down the road. His car is capable of slowing down with an acceleration rate of -6 m/s^2 . If the speed limit sign is 50 m from the car, can he slow down to 20 m/s by the time he reaches the sign? The following questions will lead you to the answer:

- How much time will it take the car to slow from 35 m/s to 20 m/s?
- What is the car's average velocity during the time it is slowing down?
- How far does the car travel as it is slowing down?
- Does he make it?

Notice that there are several parts to the question. You need to show work for each part.

It is important to organize your work so that you make sure you answer each part of the question and so that the grader can follow your work. To do this, **label each part of your work.**

For a calculation, there are three parts that you need to show:

- The relevant equation
- Substitution of values into the equation with units
- Final answer with units.

a.

$$V_2 = V_1 + at$$

The relevant equation is written.

$$t = (V_2 - V_1) / a$$

For this question, some algebra is required, so show that too.

$$t = (20 \text{ m/s} - 35 \text{ m/s}) / (-6 \text{ m/s}^2)$$

Show the values and units you are substituting into the Equation.

$$t = 2.5 \text{ s}$$

Show your final answer with units.

Now continue with each part:

b.

$$V_{\text{avg}} = (V_1 + V_2) / 2$$

c.

$$d = V_{\text{avg}} \times t$$

$$V_{\text{avg}} = (35 \text{ m/s} + 20 \text{ m/s}) / 2$$

$$d = 27.5 \text{ m/s} \times 2.5 \text{ s}$$

$$V_{\text{avg}} = 27.5 \text{ m/s}$$

$$d = 55 \text{ m}$$

Part d is a little different - it doesn't require a calculation - it is a question to answer based on the work from part a to c. It requires a written answer.

For written answers, you also want to be organized. In this case, organized means:

- Complete sentences with correct grammar and spelling.
Using complete sentences helps you to organize your thoughts and give a complete answer that the grader can understand.
- Use the Claim, Evidence, Reasoning set up.
Claim - a statement about results - your answer
Evidence - data or calculation results used to support your claim.
Reasoning - how does the evidence support your claim?

The driver cannot slow down to 20 m/s by the time he reaches the sign. The driver requires a distance of 55 m to slow to 20 m/s but the sign is only 50 m away - he is 5 m past the sign when he reaches 20 m/s.

Notice that "showing your work" for a written question does not necessarily mean giving a long answer. In fact, it often means the opposite.

Unless it is a question specifically designed to require a paragraph length answer (and we will be working with some of these), you should try to answer in one to three sentences. More than that and you are likely giving irrelevant information that will use up your time, confuse the grader, and make it more likely that you will make an error.

Some things to remember:

Calculate means you can use equations and mathematics.

Explain or support your answer means you must use words - equations can be used as part of the answer, but the answer cannot just be a calculation.

Section 1:

Graphing Review

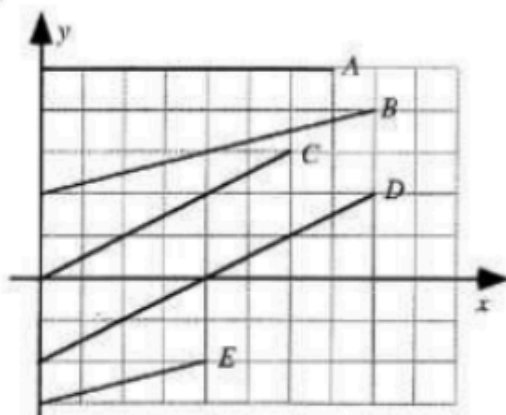
A greater emphasis has been placed on conceptual questions and graphing on the AP exam. Below you will find a few example concept questions that review foundational knowledge of graphs. Ideally you won't need to review, but you may need to review some math to complete these tasks. At the end of this part is a section covering graphical analysis that you probably have not seen before: *linear transformation*. This analysis involves converting any non-linear graph into a linear graph by adjusting the axes plotted. We want a linear graph because we can easily find the slope of the line of best fit of the graph to help justify a mathematical model or equation.

Key Graphing Skills to remember:

1. Always label your axes with appropriate units.
2. Sketching a graph calls for an estimated line or curve while plotting a graph requires individual data points AND a line or curve of best fit.
3. Provide a clear legend if multiple data sets are used to make your graph understandable.
4. Never include the origin as a data point unless it is provided as a data point.
5. Never connect the data points individually, but draw a single smooth line or curve of best fit
6. When calculating the slope of the best fit line you must use points from your line. You may only use given data points IF your line of best fit goes directly through them.

Conceptual Review of Graphs

Shown are several lines on a graph.

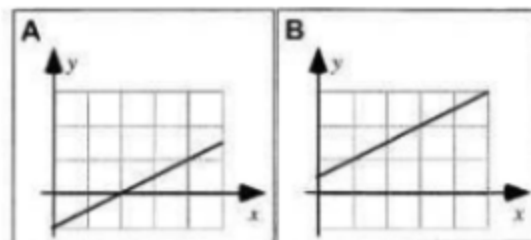


1. Rank the slopes from greatest to least.

a) $A > B = E > C = D$ b) $B = D > C = E > A$ c) $C = D > B = E > A$ d) cannot be determined.

Explain your answer:

2.



Is the slope of the graph greater in Case A, greater in Case B or the same in both?

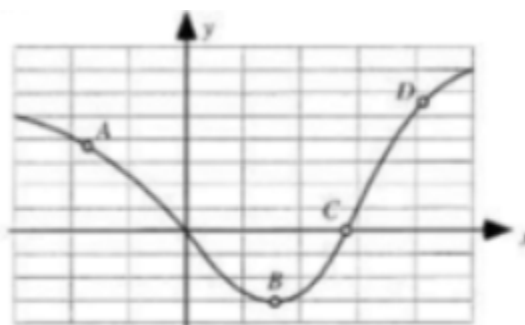
- a) Greater in A b) Greater in B c) Same in both

Explain your reasoning:

Review of graphing

3.

4 points are labeled on a graph

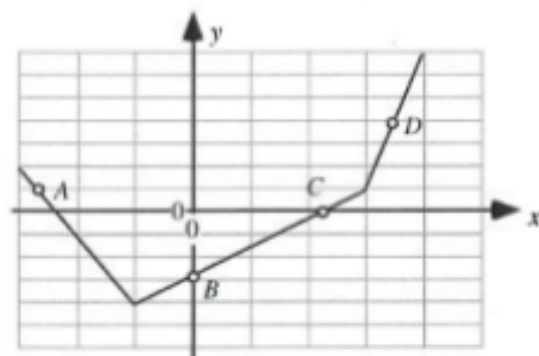


Rank the slopes from greatest to least.

- a) $C > D > B > A$ b) $C > D > A > B$ c) $A > C > D > B$ d) cannot be determined

Explain your reasoning:

4.



Rank the magnitudes (sizes) of the slopes of the graph at the labeled points.

				OR			
1	2	3	4		All	All	Cannot
Greatest			Least		the same	zero	determine

Explain your reasoning.

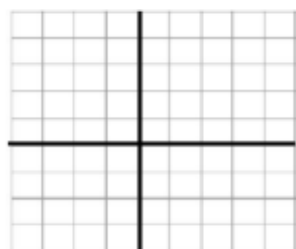
Section 2

Linearization

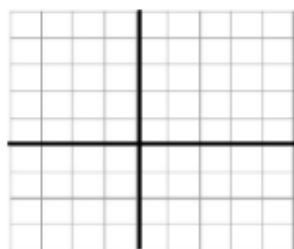
<https://www.youtube.com/watch?v=r6H99NUw5S0&list=PL9PrkIRFdvQOB4CFY8v1EieLMFTIHkCVQ>

You must understand functions to be able to linearize. First let's review what graphs of certain functions look like. Sketch the shape of each type of y vs. x function below. k is listed as a generic constant.

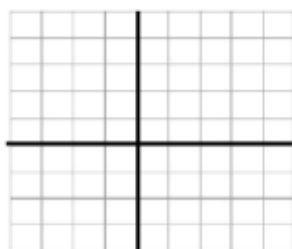
Linear $y = kx$



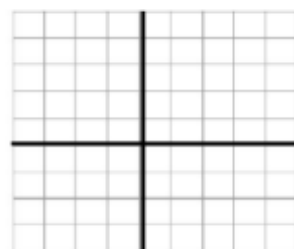
Inverse $y = k/x$



Inverse Square $y = k/x^2$



Power $y = kx^2$



You will notice that only the linear function is a straight line. We can easily find the slope of our line by measuring the rise and dividing it by the run of the graph or calculating it using two points. The value of the slope should equal the constant k from the equation.

Finding k is a bit more challenging in the last three graphs because the slope isn't constant. This should make sense since your graphs aren't linear. So how do we calculate our constant, k ?

We need to transform the non-linear graph into a linear graph in order to calculate a constant slope. We can accomplish this by transforming one or both of the axes for the graph. The hardest part is figuring out which axes to change and how to change them. The easiest way to accomplish this task is to solve your equation for the constant. (Note in the examples from the last page there is only one constant, but this process could be done for other equations with multiple constants. Instead of solving for a single constant, put all of the constants on one side of the equation.)

When you solve for the constant, the other side of the equation should be in fraction form. This fraction gives the rise and run of the linear graph (the numerator is the rise, the denominator is the run). Whatever is in the numerator is the vertical axis and the denominator is the horizontal axis. If the equation is not in fraction form, you will need to inverse one or more of the variables to make a fraction, so $k = xy$ would be written as $k = \frac{x}{\frac{1}{y}}$ which is mathematically the same but

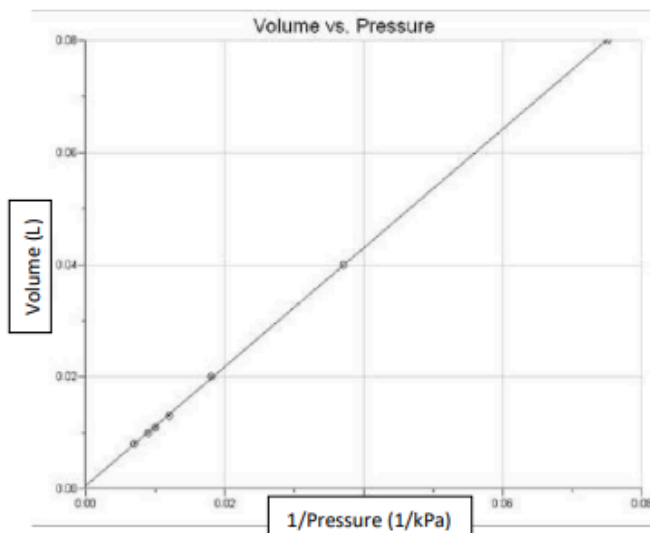
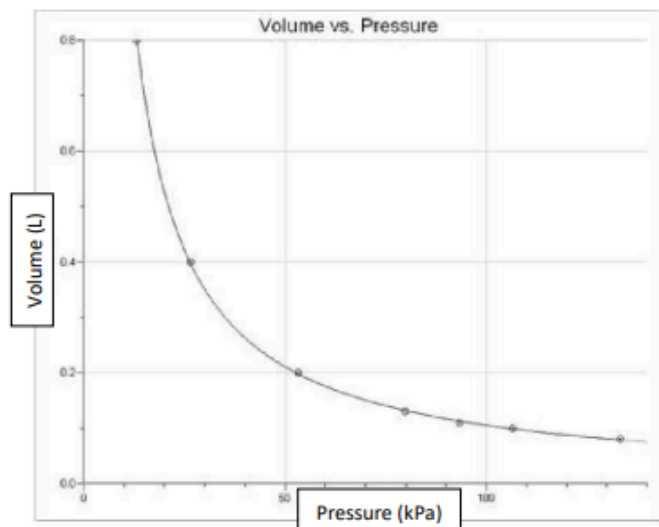
show us we need to make the vertical axis x and the horizontal axis $\frac{1}{y}$ since x is in the numerator and $\frac{1}{y}$ is in the denominator. First let's solve each equation to figure out what we should graph. Then look below at the example and complete the last one, a sample AP question, on your own.

State what should be graphed in order to produce a linear graph to solve for k .

- | | | |
|-----------------------------|-------------------------------|---------------------------------|
| 5. Inverse Graph | Vertical Axis Variable: _____ | Horizontal Axis Variable: _____ |
| Inverse Square Graph | Vertical Axis Variable: _____ | Horizontal Axis Variable: _____ |
| Power (Square) Graph | Vertical Axis Variable: _____ | Horizontal Axis Variable: _____ |

Chemistry Example

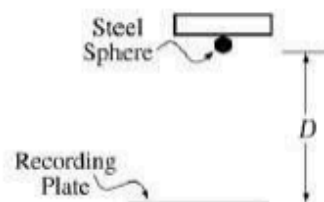
Let's look at an equation you should remember from chemistry. According to Boyle's law, an ideal gas obeys the following equation $P_1V_1 = P_2V_2 = k$. This states that pressure and volume are inversely related (as one goes up the other goes down), and the graph on the left shows an inverse shape. Although the equation is equal to a constant, the variables are not in fraction form. One of the variables, pressure in this case, is inverted. This means every pressure data point is divided into one to get the inverse. The graph on the right shows the linear relationship between volume V and the inverse of pressure $1/P$. We could now calculate the slope of this linear graph to find k .



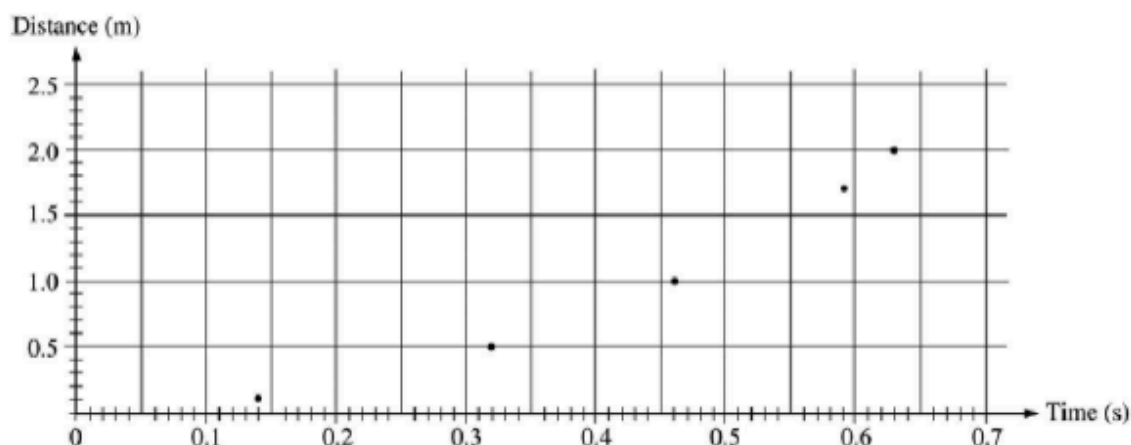
6.

Sample AP Graphing Exercise

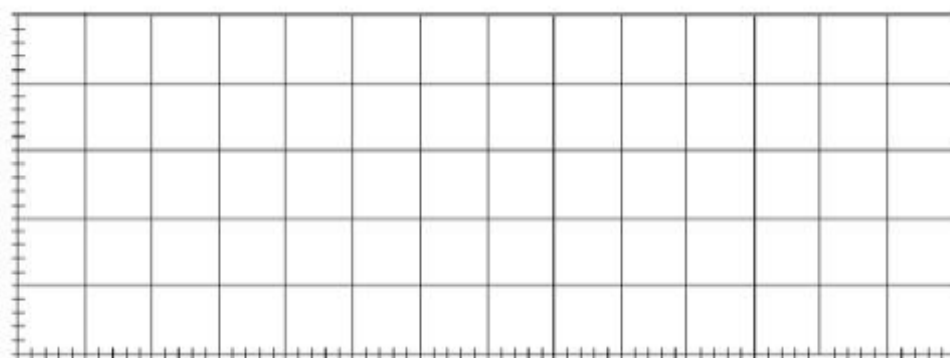
A steel sphere is dropped from rest and the distance of the fall is given by the equation $D = \frac{1}{2}gt^2$. D is the distance fallen and t is the time of the fall. The acceleration due to gravity is the constant known as g . Below is a table showing information on the first two meters of the sphere's descent.



Distance of Fall (m)	0.10	0.50	1.00	1.70	2.00
Time of Fall (s)	0.14	0.32	0.46	0.59	0.63



- Draw a line of best fit for the distance vs. time graph above (it should be a curve that goes through the dots).
- If only the variables D and t are used, what quantities should you graph in order to produce a linear relationship between the two quantities (remember: first solve the equation for g , then look at what's on the numerator and what's on the denominator)?
- On the grid below, plot the data points for the quantities you have identified in part (b), and sketch the straight-line fit to the points. **Label your axes and show the scale that you have chosen for the graph.**

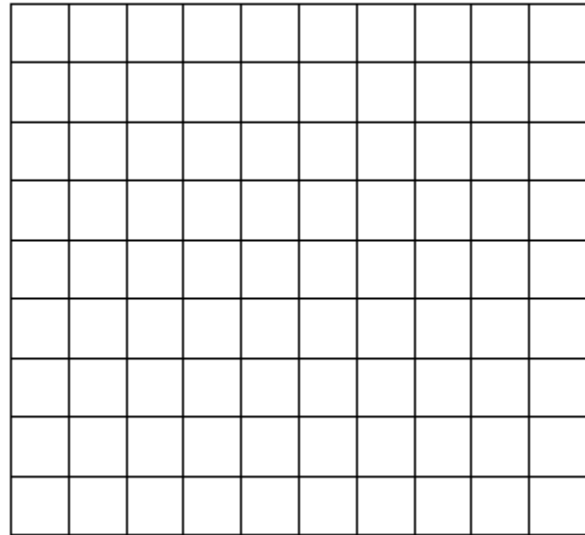


- Calculate the value of g by finding the slope of the graph.

7. Remember to always spread the data out to take full use of the graph's axes and label them with quantities and correct units. Do not break the graph unless absolutely necessary. Your graph also needs a title.

Take the following data and create a distance versus time graph (get used to having time on the x-axis). Never connect the dots as it is a scatter plot.

Distance (m)	Time (s)
0.0	0.0
3.6	1.0
7.1	2.0
11.1	3.0
14.6	4.0
18.2	5.0



8. Add in a best-fit line with a straight edge. Write briefly what two things make a “best-fit line”.

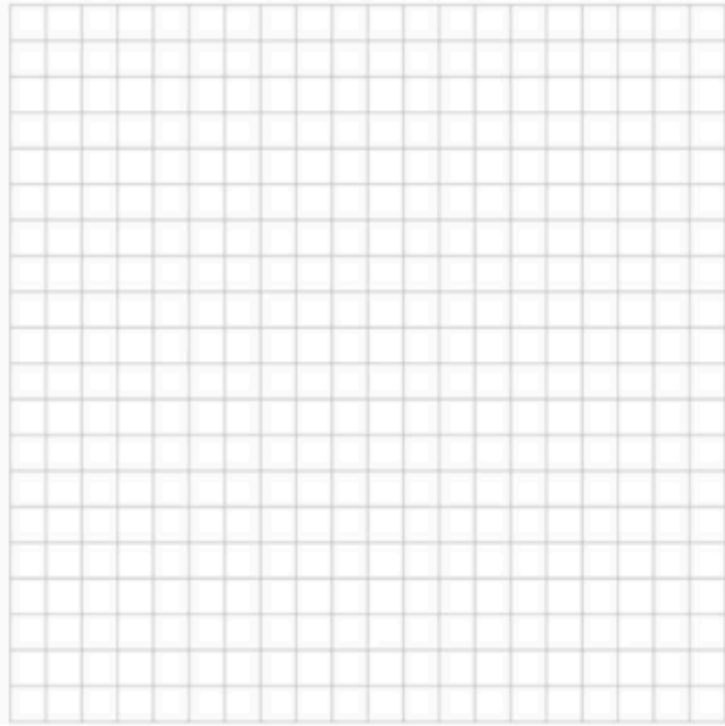
9. Calculate the slope of your best-fit line, with showing all your work. Include your units with the answer.

10. What relationship is found between the distance and time?

11. Given the following data and axis, answer the questions:

1. Using the following data, plot a graph of Velocity vs. Time.

Velocity (m/s)	Time (s)
14	1
24	2
37	3
46	4
59	5
68	6
81	7



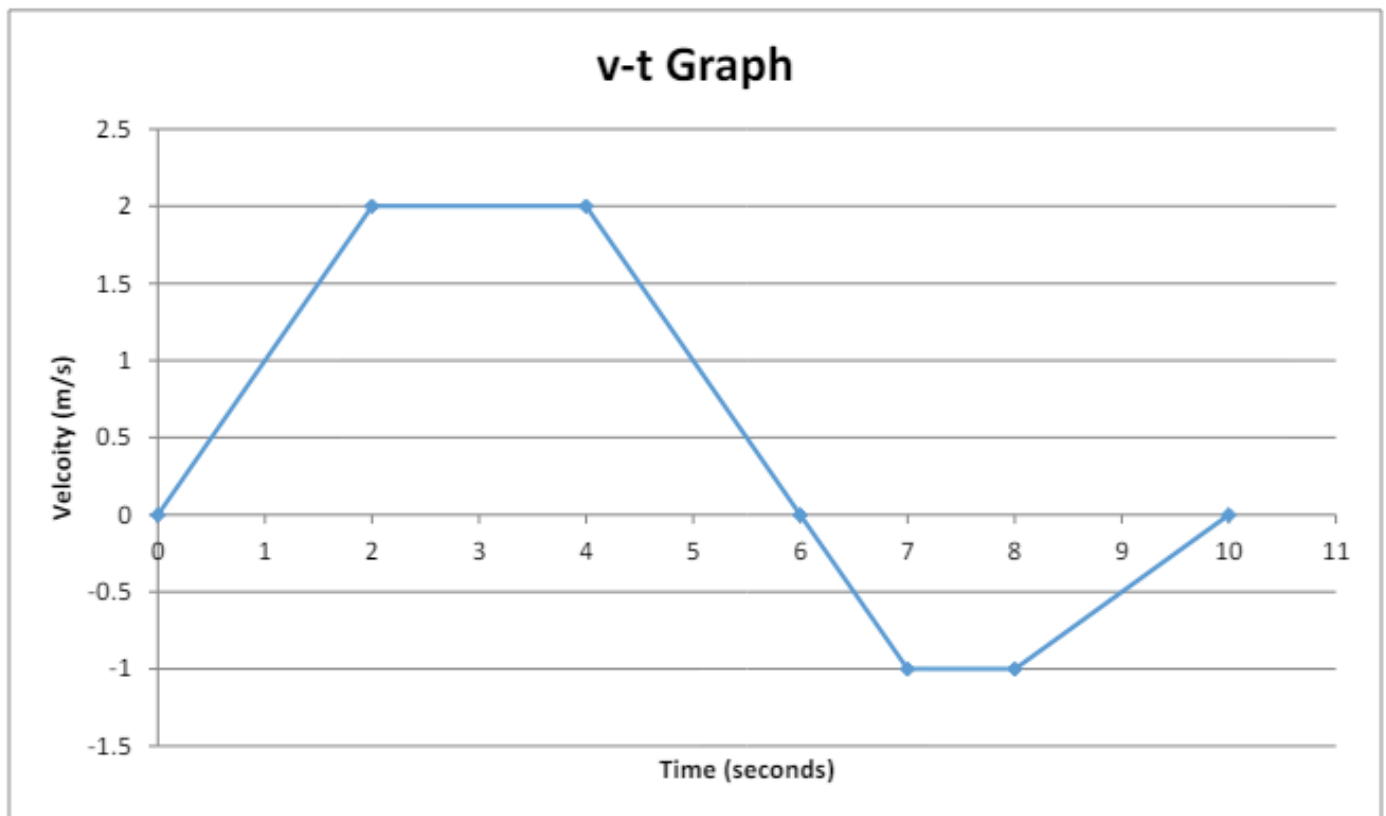
Draw the best fit line and determine the equation of the line (use the actual variable that are graphed - not x and y)

- What is the value of the slope - with proper units - and what physical quantity does it represent?
- What is the value of the y intercept - with proper units - and what physical quantity does it represent?
- Use your equation to estimate how fast this object will be going at 15 seconds.

12. Graphing/Data Analysis Cont

area under a v vs t graph

https://www.khanacademy.org/science/physics/one-dimensional-motion/acceleration_tutorial/v/why-distance-is-area-under-velocity-time-line



This graph depicts a car starting from rest and moving to the right (positive direction). Interpret the graph and answer the questions below and remember to show your work when calculating.

13. What is the slope of the line from 4 seconds to 7 seconds, show your work?

14. What is the area under the curve between 0 seconds and 2 seconds, show your work?

15. At what time(s) is the car not moving? Explain

16. During which period is the car moving to the left? When did it turn around? Explain.

There will be times throughout the year when you will be required to go online to complete online simulation labs as well as research topics being discussed in the class. Here is your first. One of the best resources for basic physics understanding and application is www.physicsclassroom.com, so be sure to bookmark it for future reference (hyperphysics is another).

You will use this website to complete the following questions and graphs, which will give you the foundation needed for not only the first unit of study (Kinematics), but for the whole course as it is cumulative.

Go to www.physicsclassroom.com Click on the link on the left for "The Physics Classroom Tutorial" In the middle under "The Physics Classroom Topics" choose the link "1-D Kinematics" Take your time, record some notes for yourself and slowly read over all the material found in lesson 1 through lesson 6. Answer and complete the following:

Lesson 1

17. Describe in your own words the meaning of a vector's magnitude.

18. Differentiate between displacement and distance and include the following: when are they ever the same and when are they different?

19. Do the same as above for question 50 but for speed and velocity.

20. How does acceleration relate to velocity and give an example of when one would experience a negative acceleration?

Lesson 2

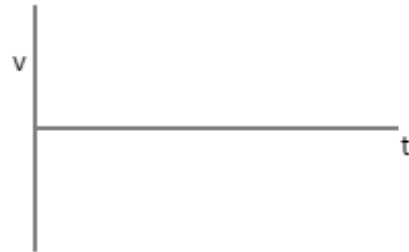
21. Draw an example of a ticker-tape diagram (motion diagram) for an automobile accelerating from rest and moving to the right.

Lesson 3 and 4

22. Sketch a position versus time (position-time or x - t) graph and a velocity versus time (v - t) graph for each of the following scenarios (assume right is positive for both displacement and velocity):
- A car moving to the right at a constant velocity



- A car moving to the right with an increasing velocity



- A car moving to the right with a decreasing velocity



Lesson 5

23. What is the symbol for gravity and what value does it represent (memorize both for the whole year!)?
24. Explain the term “free fall” in your own words.

25. Draw the curves for both x - t and v - t graphs below for an object in free fall assuming up is positive (the object would be dropping down toward the surface of Earth).



26. Suppose the object was affected by air resistance. What value would the acceleration on the object above have now? Does it change anytime during its fall? Describe the motion of its fall.

27. If there was no air resistance, which object falls faster: an unfolded piece of paper or an anvil? Why?

Lesson 6

Although physicsclassroom.com writes them differently, these are the first equations you will learn/use throughout the whole year (cumulative remember that!):

$$v = \Delta x / \Delta t \quad v_f = v_i + at \quad v_f^2 = v_i^2 + 2a(\Delta x) \quad x_f = x_i + v_i t + \frac{1}{2} at^2$$

These equations are used often and can have their x-displacements switched with y-displacements for vertical motion.

28. Which one would be best to find the displacement of the object after freely falling for 6.0 seconds, assuming it fell in the absence of air resistance and it still has not hit the ground?

Solve this problem and show all steps of work (you will need to replace the variables x with y as the object is moving only on the y-axis).

29. A ball is rolling on the ground with a speed of 2.0 m/s. If it comes to a complete stop in 6.0 seconds, how far has it traveled in total during the 6.0 second interval?

30. Sketch the x-t and v-t graphs for this ball.



31. At $t_0 = 0$, an object is moving to the right with an initial speed of 7.1 m/s but has an acceleration going to the left, which is a constant -5.8 m/s/s. a. If a time of 3.9 seconds has gone by, how far left is it now than its original position at time t_0 ? b. What is its total distance traveled

Watch the given videos in each set, then answer the questions that follow them.

Acceleration

<https://www.khanacademy.org/science/mechanics-essentials/xaafb2c8d81b6e70e3:how-to-analyze-car-crashes-using-skid-mark-analysis/xaafb2c8d81b6e70e3:how-to-find-the-acceleration-from-a-speedometer/v/acceleration>

airbus problems

https://www.khanacademy.org/science/physics/one-dimensional-motion/acceleration_tutorial/v/airbus-a380-take-off-time

https://www.khanacademy.org/science/physics/one-dimensional-motion/acceleration_tutorial/v/airbus-a380-take-off-distance

area under a v vs t graph

https://www.khanacademy.org/science/physics/one-dimensional-motion/acceleration_tutorial/v/why-distance-is-area-under-velocity-time-line

32. A jet plane lands with a speed of 100 m/s and can accelerate at a maximum rate of -5.00 m/s^2 as it comes to rest.
- From the instant the plane touches the runway, what is the minimum time needed before it can come to rest?
 - Can this plane land on a small tropical island airport where the runway is 0.800 km long?
33. A car accelerates uniformly from rest to a speed of 40.0 miles per hour in 12 sec. Find
- the distance the car travels during this time and
 - the constant acceleration of the car.

Average velocity for constant acceleration

https://www.khanacademy.org/science/physics/one-dimensional-motion/kinematic_formulas/v/average-velocity-for-constant-acceleration

34. What do positive and negative signs tell you about velocity?

35. A man drives a car. He is in a town notorious for giving speeding tickets, so he is very careful to monitor his speed and keep it at the legal 35 m/s through town, but, during his trip through town, he accelerates. Explain.
(You might want to look up clear definitions for velocity and acceleration)

Deriving displacement as a function of time, acceleration and initial velocity

https://www.khanacademy.org/science/physics/one-dimensional-motion/kinematic_formulas/v/deriving-displacement-as-a-function-of-time-acceleration-and-initial-velocity

36. a. What is the acceleration of a projectile (an object that is dropped or thrown) on Earth?

b. What assumption do we make about g ? Why do we make that assumption?

c. What do positive and negative mean for projectile motion? Why is g negative?

d. Write the equation for displacement in terms of initial velocity, acceleration and time.

Plotting projectile displacement acceleration and velocity

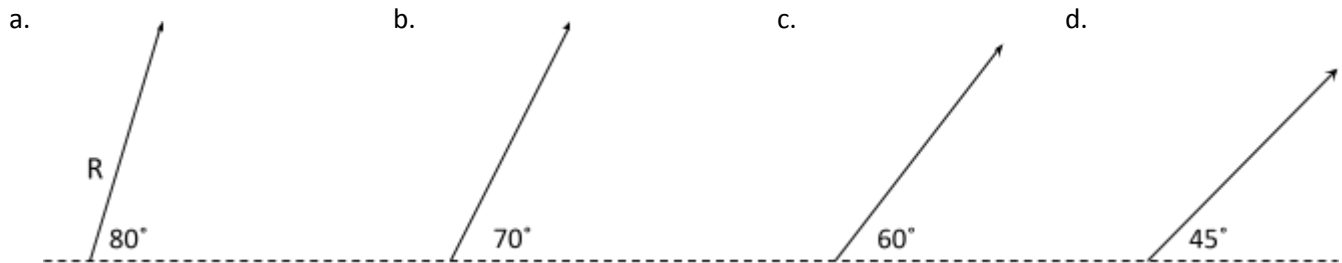
https://www.khanacademy.org/science/physics/one-dimensional-motion/kinematic_formulas/v/plotting-projectile-displacement-acceleration-and-velocity

37. a. What happens to the displacement of a projectile as it rises and falls?
- b. What happens to the velocity of a projectile as it rises and falls?
- c. What is the velocity of a projectile at the highest point in its path? What is the projectile's acceleration at this point?
- d. What is the acceleration of the projectile as it rises and falls?
- e. Assuming the projectile returns to the same height from which it was launched, compare:
- i. Rise time and fall time
 - ii. Initial velocity (starting up) and final velocity (with which it returns)

Breaking vectors into components:

<https://www.khanacademy.org/math/precalculus/vectors-precalc/magnitude-direction/v/mag-dir-vec-sums>

38. Break up the following vectors into their vertical and horizontal components i.e. the R_x and R_y . The length of each vector R is 10.0 cm.

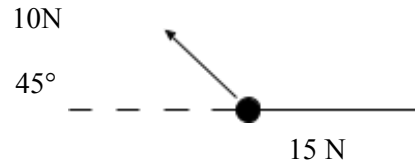


39. As the angle the vector makes with the horizontal increases, what happens to

- The x component of the vector?
- The y component of the vector?

40. If a vector were at an angle of 90 degrees to the horizontal, what would its x and y components be? (prove it)

41. The diagram below depicts all the forces acting on an object. Use both vector resolution and vector addition to find the final resultant force acting on the box. (Follow the directions below the diagram).



Directions: Resolve the 10N vector into its horizontal and vertical components. (show work)

Resolve the 15 N vector into its horizontal and vertical components.(show work)

- a. Combine the horizontal components (pay attention to direction)
- b. Combine the vertical components (pay attention to direction)
- c. Use the resulting horizontal and vertical components to do two-dimensional vector addition. Find the magnitude and direction of the resultant vector. (Show work)

42. A student walks 300 m directly East, then turns and walks 500 m directly North.

- a. Calculate the distance the student traveled.
- b. Calculate the students displacement, including direction.