AP Physics 1 – Summer Assignment 2023

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 Khan Academy to complete your summer 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 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 that you are using
- Show the plug is with number
- 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:

a) How much time will it take the car to slow from 35 m/s to 20 m/s?
b) What is the car's average velocity during the time it is slowing down?
c) How far does the car travel as it is slowing down?
d) 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.

$t = (20\ m/s - 35\ m/s) / (-6\ m/s^2)$ Show the values and units you are substituting into the Equation.

$t = 2.5\ s$ Show your final answer with units.

Now continue with each part:

b.

$V\ avg = (V_1 + V_2) / 2$

$V\ avg = (35\ m/s + 20\ m/s) / 2$

$V\ avg = 27.5\ m/s$

c.

$d = V\ avg \times t$

$d = 27.5\ m/s \times 2.5\ s$

$d = 55\ m$

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 and confuse the grader.

Okay - now onto the assignment:
Answer all questions on looseleaf. You need to be organized - number your questions - use the model above to present your answers.

All questions require an explanation - **yes even multiple choice questions.**

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.

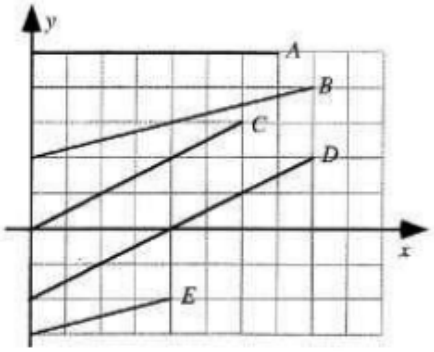
Key Graphing Skills to remember:

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.

Slope Review: http://bit.ly/2Ko8P3e

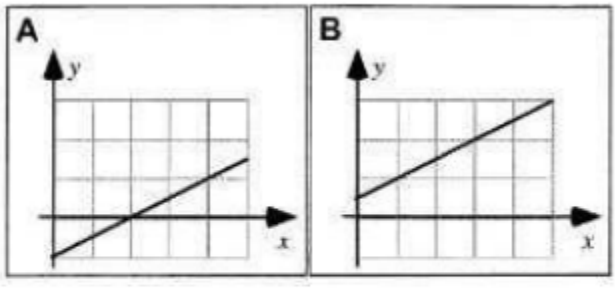
Conceptual Review of Graphs

Shown are several lines on a graph.



141) Rank the slopes of the lines in this graph.

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



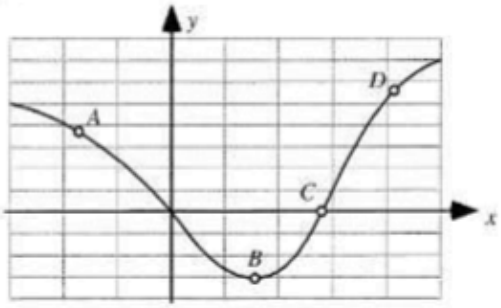
142) Is the slope of the graph greater in Case A, greater in Case B or the same in both?

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

Before you start this, you might want to review graphing:

https://www.youtube.com/watch?v=5YW7vaQuP_E

Four points are labeled on a graph.

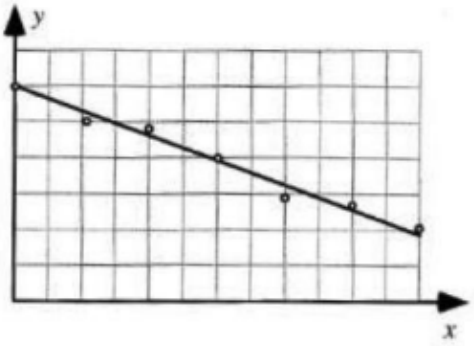


143) Rank the slopes of the graph at the labeled points.

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

A student makes the following claim about some data that he and his lab partners have collected:

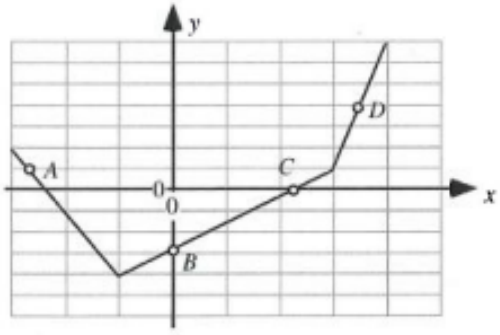
"Our data show that the value of y decreases as x increases. We found that y is inversely proportional to x."



144) What, if anything, is wrong with this statement?

a) The statement is correct.
b) The statement is wrong because "inversely proportional" means they should both increase.
c) The statement is wrong because the graph does not show that *y* decreases as *x* increases.
d) The statement is wrong because the data points are not directly on the line that was drawn.

145)



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

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

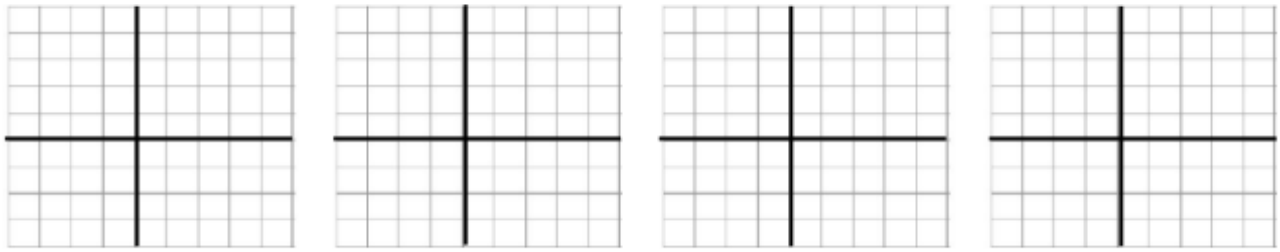
Explain your reasoning.

Section 2
Linearization

https://www.youtube.com/watch?v=zzkOmEExc94

You must understand functions to be able linearize. First let's review what graphs of certain functions looks 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.)

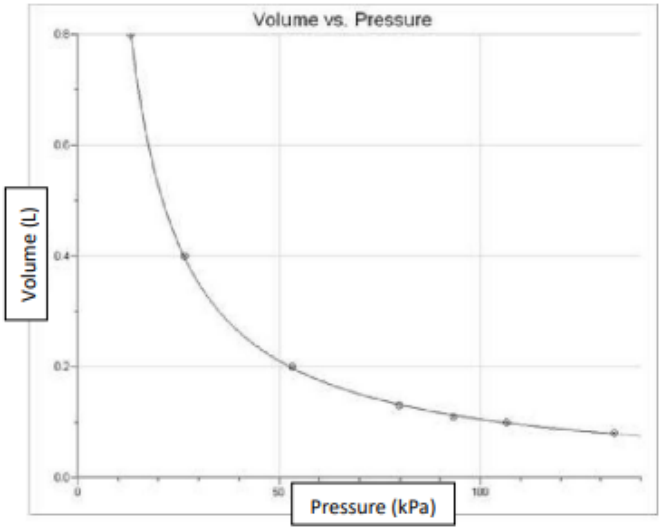
When you solve for the constant, the other side of the equation should be in fraction form. This fraction gives the rise and run of the linear graph (the numerator is the rise, the denominator is the run). Whatever is in the numerator is the vertical axis and the denominator is the horizontal axis. If 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.

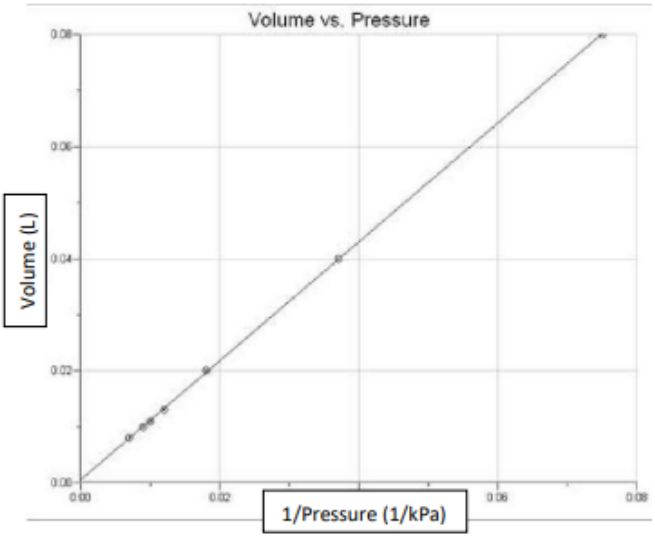
State what should be graphed in order to produce a linear graph to solve for *k*.

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

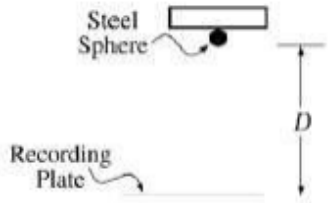
Let's look at an equation you should remember from chemistry. According to Boyle's the law, an ideal gas obeys the following equation $P_1V_1 = P_2V_2 = k$. This states that pressure and volume are inversely related (as one goes up the other goes down), and the graph on the left shows an inverse shape. 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.



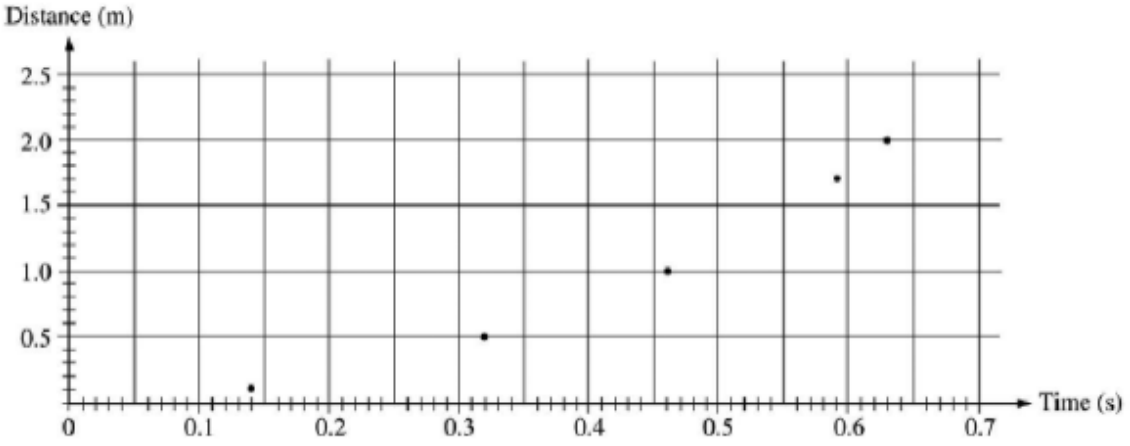


Sample AP Graphing Exercise

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.



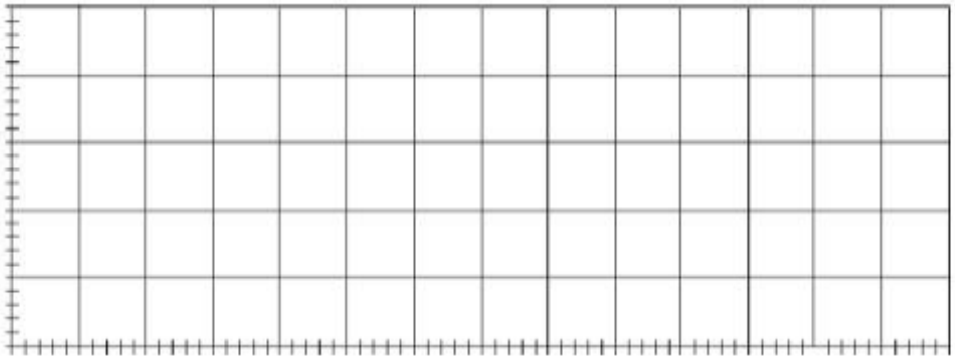
Distance of Fall (m)	0.10	0.50	1.00	1.70	2.00
Time of Fall (s)	0.14	0.32	0.46	0.59	0.63



a) Draw a line of best fit for the distance vs. time graph above (it should be a curve that goes through the dots).

b) 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)?

c) 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.**



d) Calculate the value of g by finding the slope of the graph.

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

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

b. What is the value of the slope - with proper units - and what physical quantity does it represent?

c. What is the value of the y intercept - with proper units - and what physical quantity does it represent?

d. Use your equation to estimate how fast this object will be going at 15 seconds.

Section 3
Vectors and scalars

Watch the following two videos. For each video, summarize the content that Mr. Khan is presenting in three sentences.

https://www.khanacademy.org/science/physics/one-dimensional-motion/displacement-velocity-time/v/introduction-to-vectors-and-scalars

1. summary:

https://www.khanacademy.org/science/physics/two-dimensional-motion/two-dimensional-projectile-mot/v/visualizing-vectors-in-2-dimensions

2. Summary:

Now find the horizontal and vertical components for the following:

a. 35 m/s at 57 degrees to the x-axis.

b. 450 N of force acting at 37 degrees to the x-axis

c. 560 m at 75 degrees to the x-axis

Calculating avg velocity or speed

https://www.khanacademy.org/science/physics/one-dimensional-motion/displacement-velocity-time/v/calculating-average-velocity-or-speed

instantaneous speed and velocity

https://www.khanacademy.org/science/physics/one-dimensional-motion/displacement-velocity-time/v/instantaneous-speed-and-velocity

1. What is the difference between avg speed/velocity and instantaneous speed/velocity?
2. Give an example of a circumstance in which avg speed is a more useful measurement and one in which instantaneous speed is a more useful measurement. Justify your answer. (That means explain why the measurement is more useful in this case.)
3. How do you find instantaneous velocity from an x vs t (displacement vs time) graph?

Acceleration

https://www.khanacademy.org/science/physics/one-dimensional-motion/acceleration_tutorial/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

1. The current indoor world record time in the 200-m race is 19.92 sec, held by Frank Fredericks of Namibia (1996)\. While the indoor record time in the one mile race is 228.5 sec, held by Hicham El Guerrouj of Morocco (1997). Find the mean speed in meters per second corresponding to these record times for (a) the 200-m event and (b) the one mile event.
2. 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.
    a. From the instant the plane touches the runway, what is the minimum time needed before it can come to rest?
    b. Can this plane land on a small tropical island airport where the runway is 0.800 km long?
3. A car accelerates uniformly form rest to a speed of 40.0 miles per hour in 12 sec. Find
    a. the distance the car travels during this time and
    b. the constant acceleration of the car.
4. To pass a physical education class at a university, a student must run 1.0 miles in 12 min. After running for 10min, she still has 500 yd to go. If her maximum acceleration is 0.15m/s^2, can she make it? If the answer is no, determine what acceleration she would need to be successful.

Average velocity for constant acceleration

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

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

6. 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.

Acceleration of aircraft carrier take off

https://www.khanacademy.org/science/physics/one-dimensional-motion/kinematic_formulas/v/acceleration-of-aircraft-carrier-takeoff

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

7. What is the acceleration of a projectile (an object that is dropped or thrown) on Earth?
8. What assumption do we make about g? Why do we make that assumption?
9. What do positive and negative mean for projectile motion? Why is g negative?
10. 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

11. What happens to the displacement of a projectile as it rises and falls?
12. What happens to the velocity of a projectile as it rises and falls?
13. What is the velocity of a projectile at the highest point in its path? What is the projectiles acceleration of the projectile at this point?
14. What is the acceleration of the projectile as it rises and falls?
15. Assuming the projectile returns to the same height from which it was launched, compare:
    a. Rise time and fall time
    b. Initial velocity (starting up) and final velocity (with which it returns)

Height of projectile

https://www.khanacademy.org/science/physics/one-dimensional-motion/kinematic_formulas/v/projectile-height-given-time

16. Rex Things throws his mother's crystal vase vertically upwards with an initial velocity of 26.2 m/s.
    a. Determine the height to which the vase will rise above its initial height.
    b. With what velocity will the vase return to its initial height?

Impact velocity from a given height

https://www.khanacademy.org/science/physics/one-dimensional-motion/kinematic_formulas/v/impact-velocity-from-given-height

17. A rock is dropped from a cliff 32 m high.
    a. With what velocity will it hit the ground?
    b. How much time will it take for the rock to hit the ground?

Center of Mass

Watch the video
https://www.khanacademy.org/science/physics/linear-momentum/center-of-mass/v/center-of-mass

And answer the following questions:

1. What is the center of mass of an object?
2. What happens if a force is applied to the center of mass of an object?
3. Why is the center of mass useful when dealing with objects?
4. Is the center of mass always at the geometric center of the object?
5. What happens if you apply a force on an object at some point that is NOT the center of mass?
6. Does the center of mass have to be contained in the object?

Watch the video

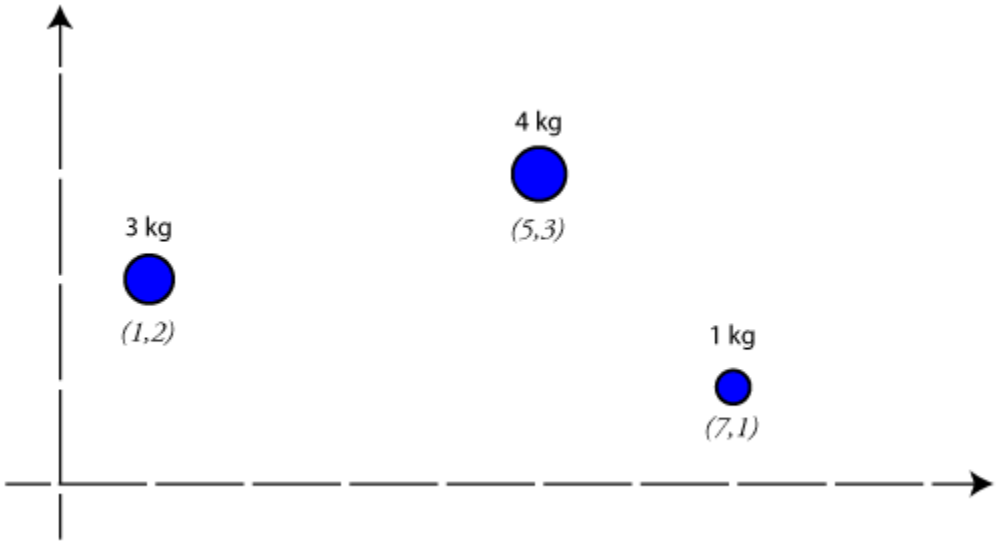
https://www.khanacademy.org/science/physics/linear-momentum/center-of-mass/v/center-of-mass-equation

And answer the following questions

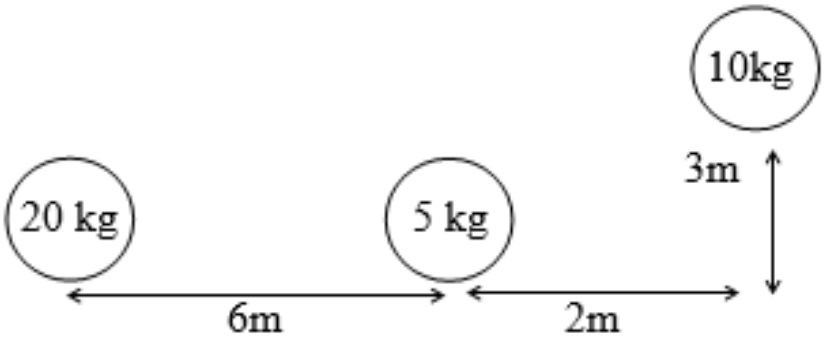
7. Calculate the center of mass of the following

Watch https://www.youtube.com/watch?v=O-q-MAYpNLI and answer the following:

8. Calculate the center of mass of the following



9. Calculate the center of mass of the following



Watch https://www.youtube.com/watch?v=nyJeaUe7wXM

10. Summarize the video