

Dear students,

Please do not be scared by the huge amount of (for now...I hope) meaningless letters and symbols that you see on the pages following the math practice starting on ***Part 5: Algebra***.

Let me clarify a simple rule: If the letter is in italics then it refers to some physical property.. If the letter is in the normal (non-italic) format then it refers to a unit of measurement.

Example 1:

m refers to meters (unit of length) while m represents the mass of an object that is measured in kg

Example 2:

N refers to Newtons (unit of force)while N stands for a normal force that is usually exerted by a flat surface such as a wall.

Other mathematical symbols such as Σ : which means summation/addition of ALL the quantities. (e.g. Σf means the addition of all the forces acting on a body).

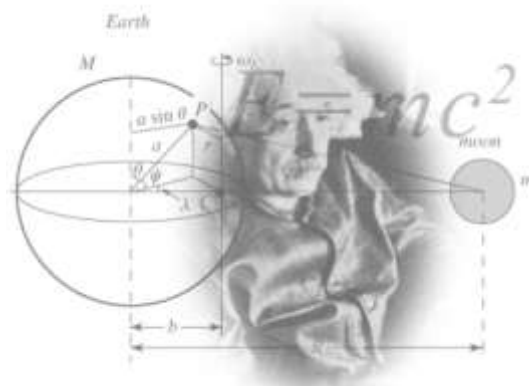
Do not confuse changing units (e.g. express 9m in cm) to substituting in the formula $m = 9kg$. This last operation which you have learned in math is substitution, in physics it means ("hey!! Let's calculate the acceleration (a) of a body if we exert a force (f) of 10N on a mass (m) of 9kg when the Second Universal Law of Newton applies a.k.a. $f = ma$).

Are you expected to know what, when or why $f = ma$ is true?.....**NO!! But I DO expect you to know how to substitute and manipulate simple algebraic formulas.**

I am looking forward to meeting you after the summer break.

AP Physics 1 Summer Assignment

Welcome to AP Physics 1! It is a college level physics course that is fun, interesting and challenging on a level you've not yet experienced. This summer assignment will review all of the prerequisite knowledge expected of you. There are 7 parts to this assignment. It is quantity not the difficulty of the problems that has the potential to overwhelm, so do it over an extended period of time. It should not take you any longer than a summer reading book assignment. By taking the time to review and understand all parts of this assignment, you will help yourself acclimate to the rigor and pacing of AP Physics 1. Use the book if you need to, but really this is all stuff you already know how to do (basic math skills). It is VERY important that this assignment be completed *individually*. It will be a total waste of your time to copy the assignment from a friend. The summer assignment will be due the first day of class. Good luck! ☺



Part 1: Scientific Notation and Dimensional Analysis

Many numbers in physics will be provided in scientific notation. You need to be able read and simplify scientific notation. **(This section is to be completed without calculators...all work should be done by hand.)** Get used to no calculator! All multiple choice portions of tests will be completed without a calculator.

Express the following the numbers in scientific notation. Keep the same unit as provided. ALL answers in physics need their appropriate unit to be correct.

1. 7,640,000 kg
2. 8327.2 s
3. 0.000000003 m
4. 0.0093 km/s

Often times multiple numbers in a problem contain scientific notation and will need to be reduced by hand. Before you practice, remember the rules for exponents.

When numbers are multiplied together, you (*add / subtract*) the exponents and (*multiply / divide*) the bases.

When numbers are divided, you (*add / subtract*) the exponents and (*multiply / divide*) the bases.

When an exponent is raised to another exponent, you (*add / subtract / multiply / divide*) the exponent.

Using the three rules from above, simplify the following numbers in proper scientific notation:

5. $(3 \times 10^6) \cdot (2 \times 10^4) =$
6. $(1.2 \times 10^4) / (6 \times 10^{-2}) =$
7. $(4 \times 10^8) \cdot (5 \times 10^{-3}) =$
8. $(7 \times 10^3)^2 =$
9. $(8 \times 10^3) / (2 \times 10^5) =$
10. $(2 \times 10^{-3})^3 =$

Fill in the power and the symbol for the following unit prefixes. Look them up as necessary. These should be **memorized** for next year. Kilo- has been completed as an example.

Prefix	Power	Symbol
Giga-		
Mega-		
Kilo-	10^3	k
Centi-		
Milli-		
Micro-		
Nano-		
Pico-		

Not only is it important to know what the prefixes mean, it is also vital that you can convert between metric units. If there is no prefix in front of a unit, it is the base unit which has 10^0 for its power, or just simply “1”. Remember if there is an exponent on the unit, the conversion should be raised to the same exponent as well.

Convert the following numbers into the specified unit. Use scientific notation when appropriate.

1. 24 g = _____ kg

5. $3.2 \text{ m}^2 = \text{_____ cm}^2$

2. 94.1 MHz = _____ Hz

6. $40 \text{ mm}^3 = \text{_____ m}^3$

3. 6 Gb = _____ kb

7. $1 \text{ g/cm}^3 = \text{_____ kg/m}^3$

4. 640 nm = _____ m

8. $20 \text{ m/s} = \text{_____ km/hr}$

For the remaining scientific notation problems you may use your calculator. It is important that you know how to use your calculator for scientific notation. The easiest method is to use the “EE” button. An example is included below to show you how to use the “EE” button.

Ex: 7.8×10^{-6} would be entered as 7.8“EE”-6

9. $(3.67 \times 10^3)(8.91 \times 10^{-6}) =$

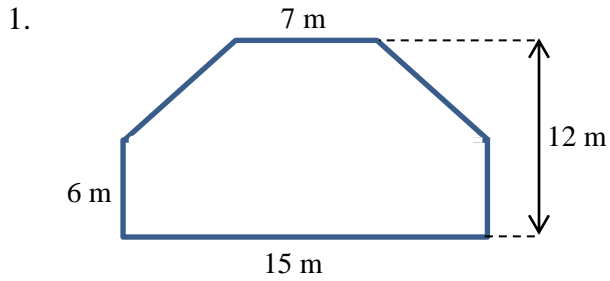
10. $(5.32 \times 10^{-2})(4.87 \times 10^{-4}) =$

11. $(9.2 \times 10^6) / (3.6 \times 10^{12}) =$

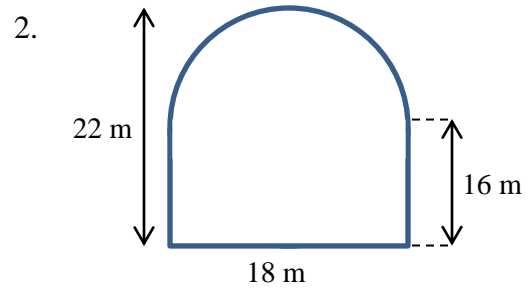
12. $(6.12 \times 10^{-3})^3$

Part 2: Geometry

Calculate the area of the following shapes. It may be necessary to break up the figure into common shapes.

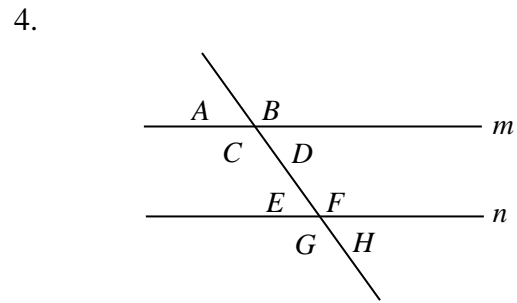
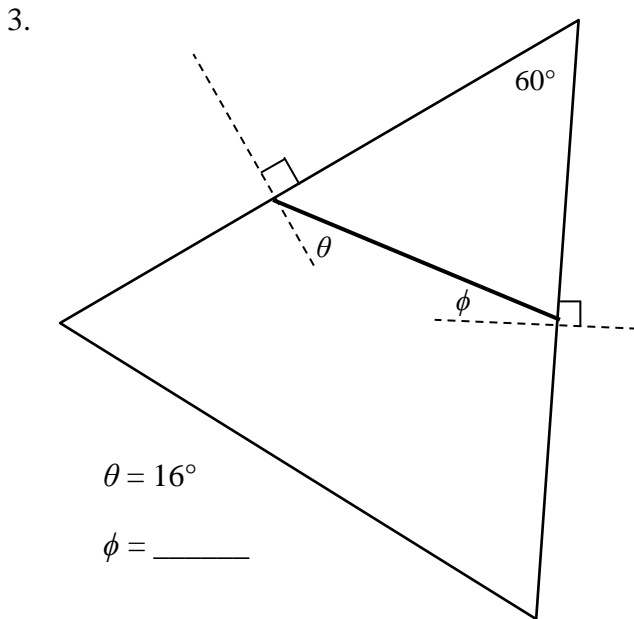


Area = _____



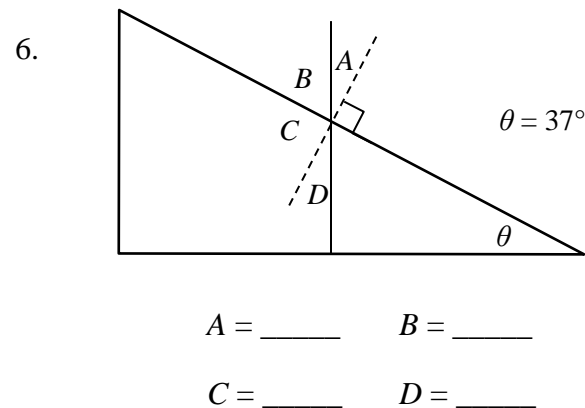
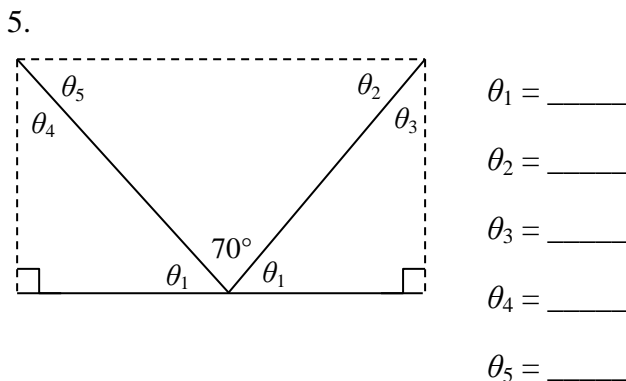
Area = _____

Calculate the unknown angle values for questions 3-6.



Lines m and n are parallel.

$A = 75^\circ$ $B = \underline{\hspace{1cm}}$ $C = \underline{\hspace{1cm}}$ $D = \underline{\hspace{1cm}}$
 $E = \underline{\hspace{1cm}}$ $F = \underline{\hspace{1cm}}$ $G = \underline{\hspace{1cm}}$ $H = \underline{\hspace{1cm}}$



Part 4: Trigonometry

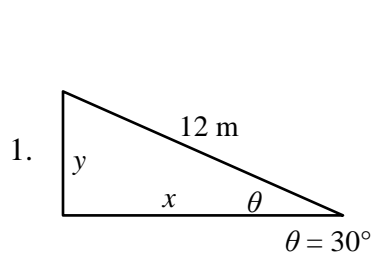
Write the formulas for each one of the following trigonometric functions. Remember SOHCAHTOA!

$\sin\theta =$

$\cos\theta =$

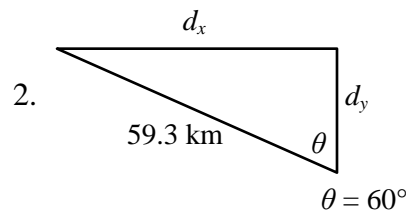
$\tan\theta =$

Calculate the following unknowns using trigonometry. Use a calculator, but show all of your work. Please include appropriate units with all answers. (Watch the unit prefixes!)



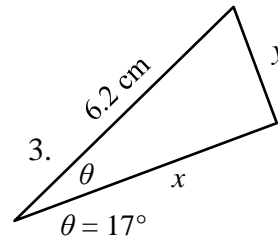
$y =$ _____

$x =$ _____



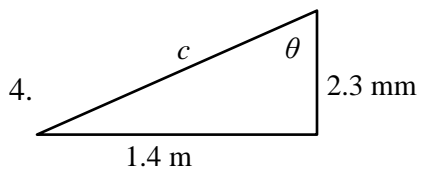
$d_x =$ _____

$d_y =$ _____



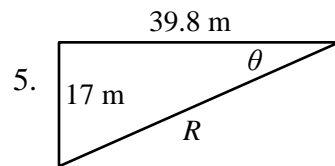
$x =$ _____

$y =$ _____



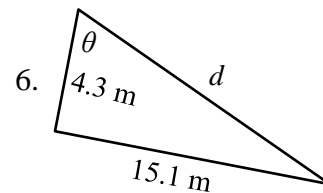
$c =$ _____

$\theta =$ _____



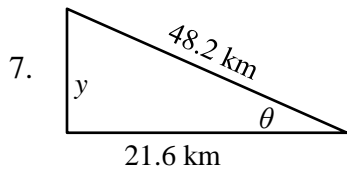
$R =$ _____

$\theta =$ _____



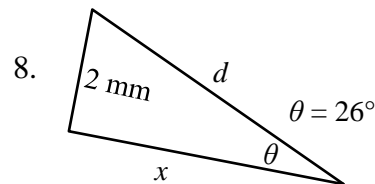
$d =$ _____

$\theta =$ _____



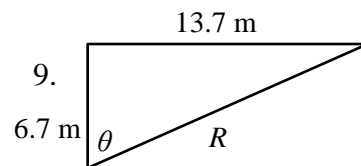
$y =$ _____

$\theta =$ _____



$x =$ _____

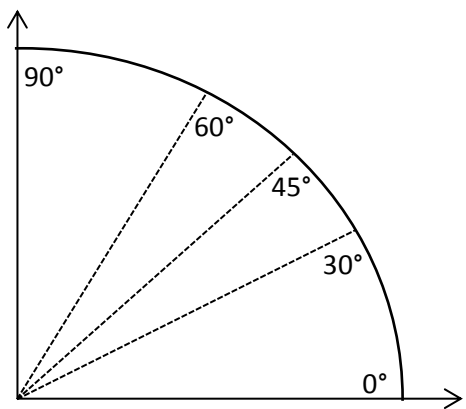
$d =$ _____



$R =$ _____

$\theta =$ _____

You will need to be familiar with trigonometric values for a few common angles. Memorizing this unit circle diagram in degrees or the chart below will be very beneficial for next year in both physics and pre-calculus. How the diagram works is the cosine of the angle is the x-coordinate and the sine of the angle is the y-coordinate for the ordered pair. Write the ordered pair (in fraction form) for each of the angles shown in the table below

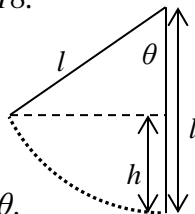


θ	$\cos\theta$	$\sin\theta$
0°		
30°		
45°		
60°		
90°		

Refer to your completed chart to answer the following questions.

10. At what angle is sine at a maximum?
11. At what angle is sine at a minimum?
12. At what angle is cosine at a minimum?
13. At what angle is cosine at a maximum?
14. At what angle are the sine and cosine equivalent?
15. As the angle increases in the first quadrant, what happens to the cosine of the angle?
16. As the angle increases in the first quadrant, what happens to the sine of the angle?

Use the figure below to answer problems 17 and 18.



17. Find an expression for h in terms of l and θ .

18. What is the value of h if $l = 6$ m and $\theta = 40^\circ$?

Part 5: Algebra

Solve the following (almost all of these are extremely **easy** – it is *important* for you to work *independently*). Units on the numbers are included because they are essential to the concepts, however they do not have any *effect* on the actual numbers you are putting into the equations. In other words, the units do not change how you do the algebra. Show every step for every problem, including writing the original equation, all algebraic manipulations, and substitution! You should practice doing all algebra *before* substituting numbers in for variables.

Section I: For problems 1-5, use the three equations below:

$$v_f = v_0 + at$$

$$x_f = x_0 + v_0t + \frac{1}{2}at^2$$

$$v_f^2 = v_0^2 + 2a(x_f - x_0)$$

- Using equation (1) solve for t given that $v_0 = 5$ m/s, $v_f = 25$ m/s, and $a = 10$ m/s².
- $a = 10$ m/s², $x_0 = 0$ m, $x_f = 120$ m, and $v_0 = 20$ m/s. Use the second equation to find t .
- $v_f = -v_0$ and $a = 2$ m/s². Use the first equation to find $t/2$.
- How does each equation simplify when $a = 0$ m/s² and $x_0 = 0$ m?

Section II: For problems 6 – 11, use the four equations below.

$$\Sigma F = ma$$

$$f_k = \mu_k N$$

$$f_s \leq \mu_s N$$

$$F_s = -kx$$

- If $\Sigma F = 10$ N and $a = 1$ m/s², find m using the first equation.
- Given $\Sigma F = f_k$, $m = 250$ kg, $\mu_k = 0.2$, and $N = 10m$, find a .
- $\Sigma F = T - 10m$, but $a = 0$ m/s². Use the first equation to find m in terms of T .
- Given the following values, determine if the third equation is valid. $\Sigma F = f_s$, $m = 90$ kg, and $a = 2$ m/s². Also, $\mu_s = 0.1$, and $N = 5$ N.
- Use the first equation in Section I, the first equation in Section II and the givens below, find ΣF .
 $m = 12$ kg, $v_0 = 15$ m/s, $v_f = 5$ m/s, and $t = 12$ s.
- Use the last equation to solve for F_s if $k = 900$ N/m and $x = 0.15$ m.

Section III: For problems 12, 13, and 14 use the two equations below.

$$a = \frac{v^2}{r}$$

$$\tau = rF\sin\theta$$

11. Given that v is 5 m/s and r is 2 meters, find a .
12. Originally, $a = 12 \text{ m/s}^2$, then r is doubled. Find the new value for a .
13. Use the second equation to find θ when $\tau = 4 \text{ Nm}$, $r = 2 \text{ m}$, and $F = 10 \text{ N}$.

Section IV: For problems 15 – 22, use the equations below.

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

$$W = F(\Delta x)\cos\theta$$

$$P = \frac{W}{t}$$

$$\Delta U_g = mgh$$

$$U_s = \frac{1}{2}kx^2$$

$$P = Fv_{avg}\cos\theta$$

14. Use the first equation to solve for K if $m = 12 \text{ kg}$ and $v = 2 \text{ m/s}$.
15. If $\Delta U_g = 10 \text{ J}$, $m = 10 \text{ kg}$, and $g = 9.8 \text{ m/s}^2$, find h using the second equation.
16. $K = \Delta U_g$, $g = 9.8 \text{ m/s}^2$, and $h = 10 \text{ m}$. Find v .
17. The third equation can be used to find W if you know that F is 10 N, Δx is 12 m, and θ is 180° .
18. Given $U_s = 12 \text{ joules}$, and $x = 0.5 \text{ m}$, find k using the fourth equation.
19. For $P = 2100 \text{ W}$, $F = 30 \text{ N}$, and $\theta = 0^\circ$, find v_{avg} using the last equation in this section.

Section V: For problems 23 – 25, use the equations below.

$$p = mv$$

$$F\Delta t = \Delta p$$

$$\Delta p = m\Delta v$$

20. p is 12 kgm/s and m is 25 kg. Find v using the first equation.
21. “ Δ ” means “final state minus initial state”. So, Δv means $v_f - v_i$ and Δp means $p_f - p_i$. Find v_f using the third equation if $p_f = 50 \text{ kgm/s}$, $m = 12 \text{ kg}$, and v_i and p_i are both zero.
22. Use the second and third equation together to find v_i if $v_f = 0 \text{ m/s}$, $m = 95 \text{ kg}$, $F = 6000 \text{ N}$, and $\Delta t = 0.2 \text{ s}$.

Section VI: For problems 26 – 28 use the three equations below.

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

$$T_p = 2\pi\sqrt{\frac{l}{g}}$$

$$T = \frac{1}{f}$$

23. T_p is 1 second and g is 9.8 m/s^2 . Find l using the second equation.
24. $m = 8 \text{ kg}$ and $T_s = 0.75 \text{ s}$. Solve for k .
25. Given that $T_p = T$, $g = 9.8 \text{ m/s}^2$, and that $l = 2 \text{ m}$, find f (the units for f are Hertz).

Section VII: For problems 29 – 32, use the equations below.

$$F_g = -\frac{GMm}{r^2}$$

$$U_g = -\frac{GMm}{r}$$

26. Find F_g if $G = 6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$, $M = 2.6 \times 10^{23} \text{ kg}$, $m = 1200 \text{ kg}$, and $r = 2000 \text{ m}$.
27. What is r if $U_g = -7200 \text{ J}$, $G = 6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$, $M = 2.6 \times 10^{23} \text{ kg}$, and $m = 1200 \text{ kg}$?
28. Use the first equation in Section IV for this problem. $K = -U_g$, $G = 6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$, and $M = 3.2 \times 10^{23} \text{ kg}$. Find v in terms of r .
29. Using the first equation above, describe how F_g changes if r doubles.

Section VIII: For problems 36 – 41 use the equations below.

$$V = IR$$

$$I = \frac{\Delta Q}{t}$$

$$P = IV$$

$$R = \frac{\rho l}{A}$$

$$R_S = (R_1 + R_2 + R_3 + \dots + R_i) = \Sigma R_i$$

$$\frac{1}{R_P} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots + \frac{1}{R_i} \right) = \sum_i \frac{1}{R_i}$$

30. Given $V = 220$ volts, and $I = 0.2$ amps, find R (the units are ohms, Ω).
31. If $\Delta Q = 0.2 \text{ C}$, $t = 1 \text{ s}$, and $R = 100 \Omega$, find V using the first two equations.
32. $R = 60 \Omega$ and $I = 0.1 \text{ A}$. Use these values to find P using the first and third equations.
33. Let $R_S = R$. If $R_1 = 50 \Omega$ and $R_2 = 25 \Omega$ and $I = 0.15 \text{ A}$, find V .
34. Let $R_P = R$. If $R_1 = 50 \Omega$ and $R_2 = 25 \Omega$ and $I = 0.15 \text{ A}$, find V .
35. Given $R = 110 \Omega$, $l = 1.0 \text{ m}$, and $A = 22 \times 10^{-6} \text{ m}^2$, find ρ .

Part 6: Graphing and Functions

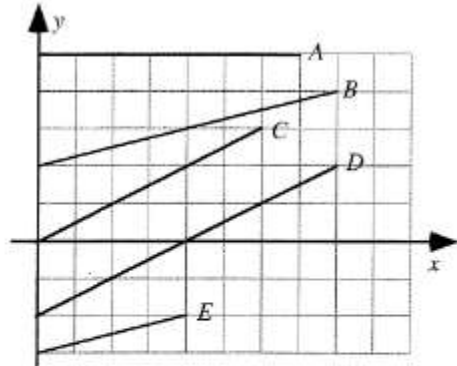
A greater emphasis has been placed on conceptual questions and graphing on the AP exam. Below you will find a few example concept questions that review foundational knowledge of graphs. Ideally you won't need to review, but you may need to review some math to complete these tasks. At the end of this 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.

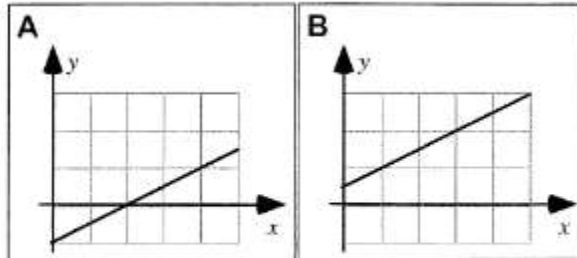


Rank the slopes of the lines in this graph.

1	2	3	4	5	OR	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Greatest				Least		All the same	All zero	Cannot determine

Explain your reasoning.

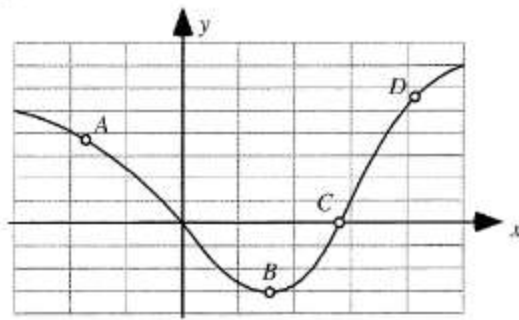
Shown are two graphs.



Is the slope of the graph (i) greater in Case A, (ii) greater in Case B, or (iii) the same in both cases? _____

Explain your reasoning.

Four points are labeled on a graph.



Rank the slopes of the graph at the labeled points.

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

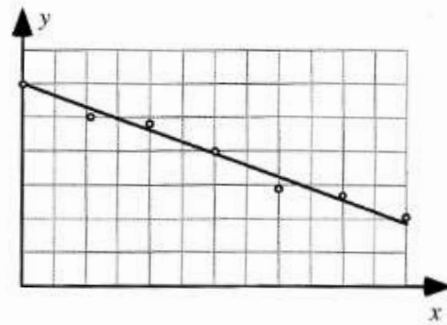
Explain your reasoning.

A1-WWT22: LINE DATA GRAPH—INTERPRETATION

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.”

What, if anything, is wrong with this statement? If something is wrong, identify and explain how to correct all errors. If this statement is correct, explain why.



Linear and Non-Linear Functions

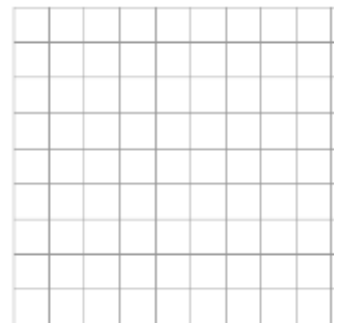
You must understand functions to be able linearize. First let’s review what graphs of certain functions looks like. Sketch the shape of each type of y vs. x function below. k is listed as a generic constant of proportionality.

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. 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. 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 .

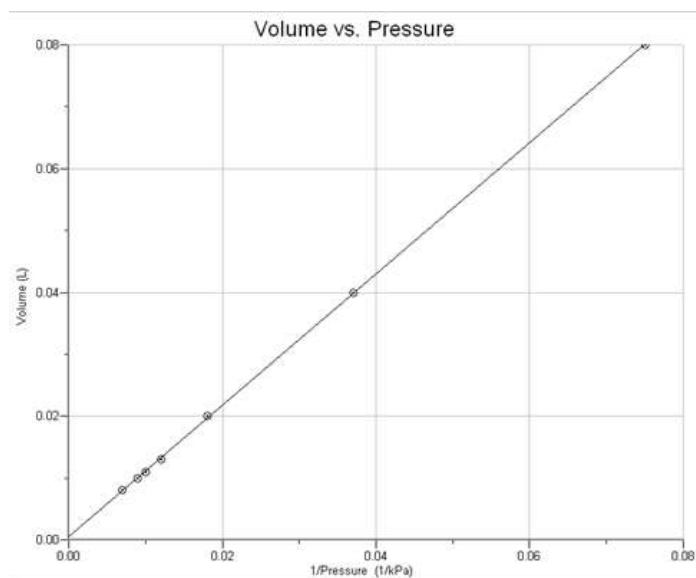
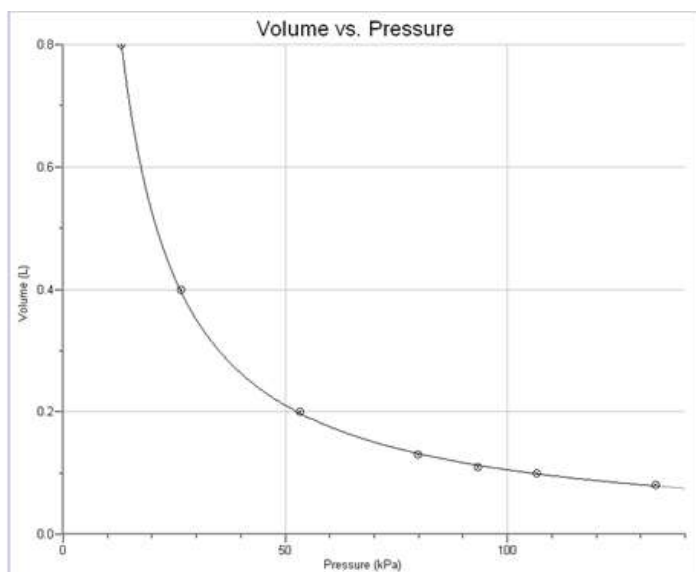
Inverse Graph Vertical Axis: _____ Horizontal Axis: _____

Inverse Square Graph Vertical Axis: _____ Horizontal Axis: _____

Power (Square) Graph Vertical Axis: _____ Horizontal Axis: _____

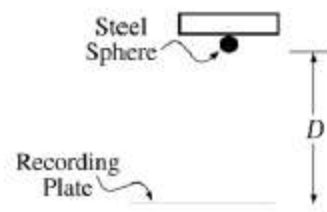
Chemistry Example

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, 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 left shows the linear relationship between volume V and the inverse of pressure $1/P$. We could now calculate the slope of this linear graph.

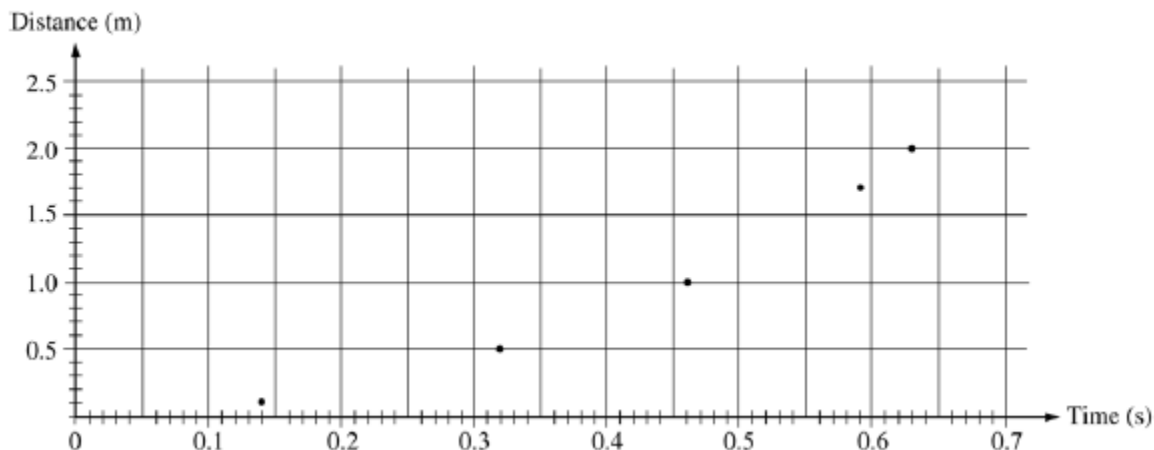


Sample AP Graphing Exercise

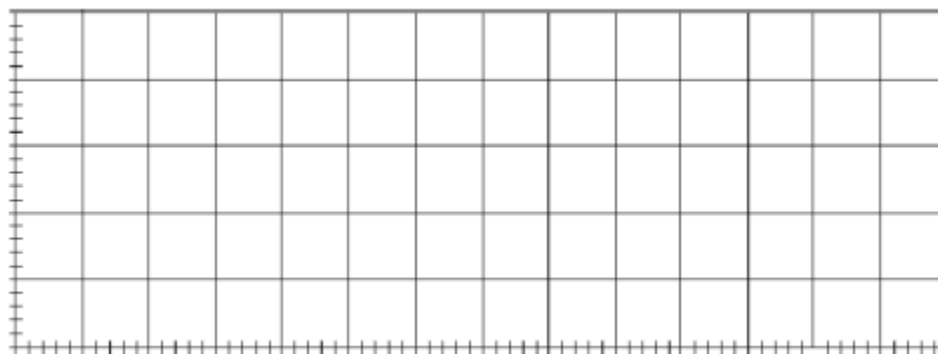
A steel sphere is dropped from rest and the distance of the fall is given by the equation $D = \frac{1}{2}gt^2$. D is the distance fallen and t is the time of the fall. The acceleration due to gravity is the constant known as g . Below is a table showing information on the first two meters of the sphere's 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.
- If only the variables D and t are used, what quantities should the student graph in order to produce a linear relationship between the two quantities?
- 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 using the slope of the graph.

Part 7: Scalars and Vectors Preview

Hooray for the Internet! Watch the following two videos. For each video, summarize the content Mr. Khan is presenting in three sentences. Then, write at least one question per video on something you didn't understand or on a possible extension of the elementary concepts he presents here.

<http://www.khanacademy.org/science/physics/v/introduction-to-vectors-and-scalars>

Summary 1

<http://www.khanacademy.org/science/physics/v/visualizing-vectors-in-2-dimensions>

Summary 2

Congratulations! You're finished! That wasn't so bad was it? *Trust me...* the blood, sweat, and tears it took to get through all of those problems will make everything later on a lot easier. Think about it as an investment with a guaranteed return.

*This course is a wonderful opportunity to grow as a critical thinker, problem solver and great communicator. Don't believe the rumors- it is not impossibly hard. It **does** require hard work, but so does anything that is worthwhile. You would never expect to win a race if you didn't train. Similarly, you can't expect to do well if you don't train academically. AP Physics is immensely rewarding and exciting, but you do have to take notes, study, and read the book (gasp!). I guarantee that if you do what is asked of you that you will look back to this class with huge sense of satisfaction! I know I can't wait to get started...*

*Let's learn some **SCIENCE!!!***