AP Physics C
Summer Assignment
Mr. Peterson

Welcome to AP Physics C! It's great that you are interested in this subject. In AP Physics C, we'll be examining the fundamentals of physics. This course covers the first year of college physics and is designed for you to develop a deep understanding of physics and to prepare you for a superior performance on the AP test.

This course is harder than any you have ever taken, and will require you to commit to working on physics every single day. To get you started, and to make sure you are interested and really want to put the work into this comprehensive and challenging topic, I've assigned some tasks for you to complete this summer, worth 100 points. Please show all the steps in your work. If insufficient work is shown because it was all done on the calculator, then your calculator will receive half the credit!

You will need to email these to me by the first day of school. It will be worth a substantial grade, and part of what will determine if AP Physics C is right for you. The other part of that consideration is a **pre-test** that we'll be taking on this material during the first week of class. Please email me at **mpeterson@tmsacademy.org** if you have any questions!

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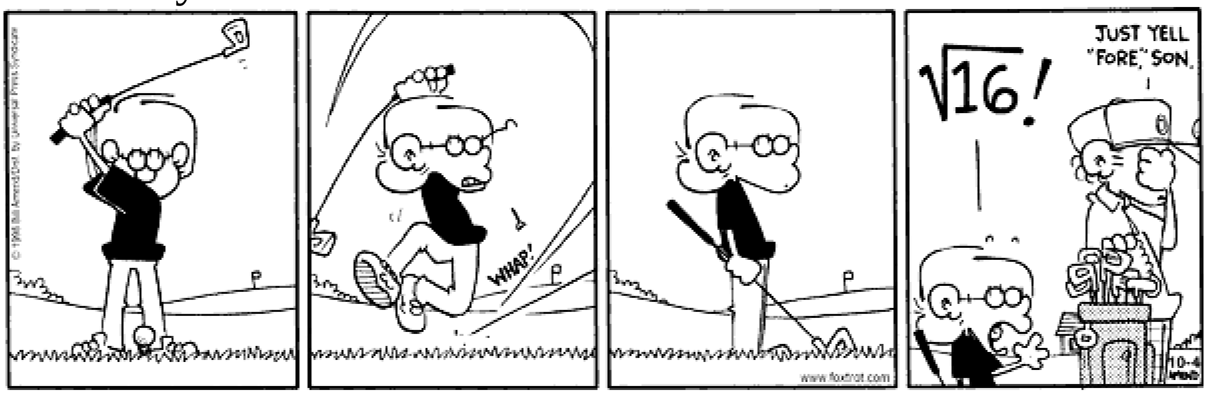
1. AP Physics – math review



PART I. SOLVING EQUATIONS

Solve the following equations for the quantity indicated.

1. $y = \frac{1}{2}at^2$ Solve for t

2. $x = v_o t + \frac{1}{2}at^2$ Solve for v_o

3. $v = \sqrt{2ax}$ Solve for x

4. $a = \frac{v_f - v_o}{t}$ Solve for t

5. $a = \frac{v_f - v_o}{t}$ Solve for v_f

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6. $F = k\frac{m_1 m_2}{r^2}$ Solve for r

7. $F = k\frac{m_1 m_2}{r^2}$ Solve for m_2

8. $T = 2\pi\sqrt{\frac{L}{g}}$ Solve for L

9. $T = 2\pi\sqrt{\frac{L}{g}}$ Solve for g

10. $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ Solve for d_i

11. $qV = \frac{1}{2}mv^2$ Solve for v (not V and v are not the same quantity)

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In each case make the specified variable the subject of the formula:

a) $h = c + d + 2e$, e b) $S = 2\pi r^2 + 2\pi rh$, h

c) $Q = \sqrt{\frac{c+d}{c-d}}$, c d) $\frac{x+y}{3} = \frac{x-y}{7} + 2$, x

PART II. SCIENTIFIC NOTATION

The following are ordinary physics problems. Write the answer in scientific notation and simplify the units.

1. $T_s = 2\pi\sqrt{\frac{4.5\times10^{-2}\text{kg}}{2.0\times10^{3}\ \text{kg/s}^2}} =$

2. $K = \frac{1}{2}\left(6.6\times10^{2}\ \text{kg}\right)\left(2.11\times10^{4}\ \text{m/s}\right)^2 =$

3. $F = 9x10^{-9}\ \frac{\text{N}\cdot\text{m}^2}{\text{C}^2}\left(\frac{(3.2x10^{-9}\text{C})(9.6x10^{-9}\text{C})}{(0.32\ \text{m})^2}\right) =$

4. $\frac{1}{R_p} = \frac{1}{4.5\times10^{2}\ \Omega} + \frac{1}{9.4\times10^{2}\ \Omega}$ $R_p =$

5. $e = \frac{\left(1.7\times10^{3}\ \text{J}\right)\text{-}\left(3.3\times10^{2}\ \text{J}\right)}{\left(1.7\times10^{3}\ \text{J}\right)} =$

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6. $(1.33)\sin 25.0^\circ = (1.50)\sin\theta$ $\theta =$

7. $K_{\text{max}} = (6.63\times10^{-34}\ \text{J}\cdot\text{s})(7.09\times10^{14}\ \text{s}^{-1}) - (2.17\times10^{-19}\ \text{J}) =$

8. $\gamma = \dfrac{1}{\sqrt{1-\dfrac{2.25\times10^{8}\ \text{m/s}}{3.00\times10^{8}\ \text{m/s}}}} =$

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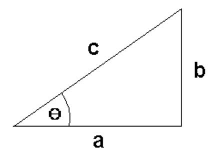
PART IV. TRIGONOMETRY AND BASIC GEOMETRY
Solve for all sides and all angles for the following triangles. Show all your work. Example:

SOH CAH TOA



$\sin\theta = \dfrac{opp}{hyp}$ $\cos\theta = \dfrac{adj}{hyp}$ $\tan\theta = \dfrac{opp}{adj}$

Your calculator must be in **degree** mode! **Show all your work.**

1. $\theta = 55^o$ and $c = 32$ m, solve for a and b

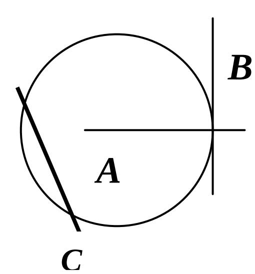
2. $\theta = 45^o$ and $a = 15$ m/s, solve for b and c.

3. $b = 17.8$ m and $\theta = 65^o$, solve for a and c.

4. Line ***B*** touches the circle at a single point. Line ***A*** extends through the center of the circle.

What is line ***B*** in reference to the circle?

How large is the angle between lines ***A*** and ***B***?



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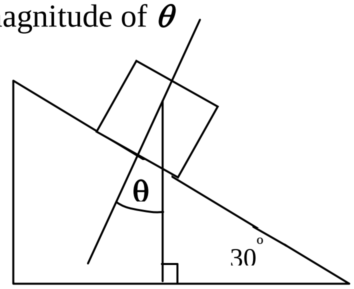
What is line ***C*?**

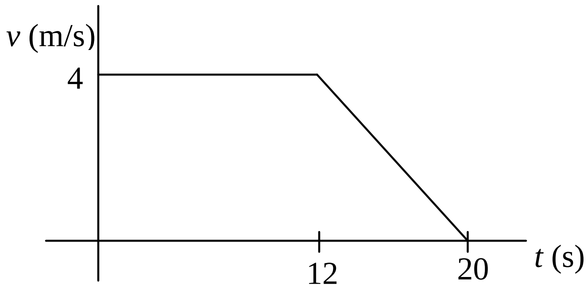
5. Write down the magnitude of $\boldsymbol{\theta}$



6. The radius of a circle is 5.5 cm,
a. What is the circumference in meters?

b. What is its area in square meters?

7. What is the area under the curve below? Show your work and include the appropriate units.



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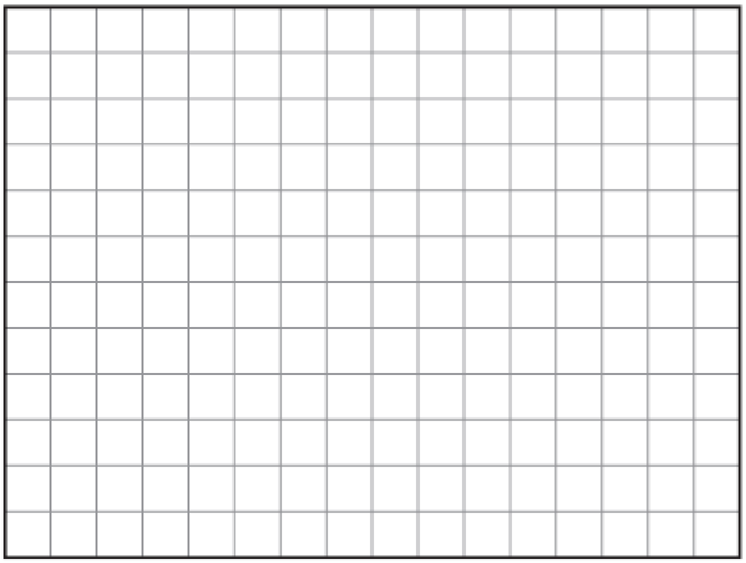
PART V. GRAPHING TECHNIQUES

Graph the following sets of data using proper graphing techniques.
The first column refers to the *y*-axis and the second column to the *x*-axis

1. Plot a graph for the following data recorded for an object falling from rest:



Velocity (ft/s)	**Time** (s)
32	1
63	2
97	3
129	4
159	5
192	6
225	7

a. What kind of curve did you obtain?

b. What is the relationship between the variables?

c. What do you expect the velocity to be after 4.5 s?

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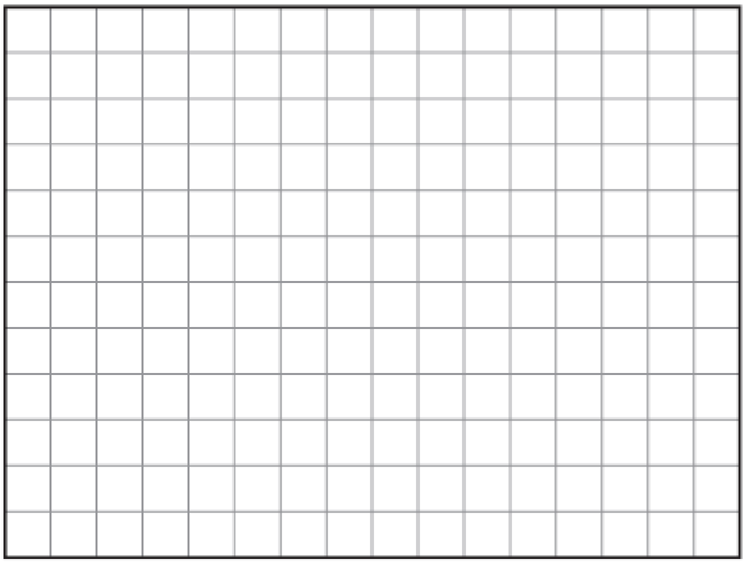
d. How much time is required for the object to attain a speed of 100 ft/s?

2. Plot a graph showing the relationship between frequency and wavelength of electromagnetic waves:



Frequency (kHz)	**Wavelength** (m)
150	2000
200	1500
300	1000
500	600
600	500
900	333

a. What kind of curve did you obtain?

b. What is the relationship between the variables?

c. What is the wavelength of an electromagnetic wave of frequency 350 Hz?

d. What is the frequency of an electromagnetic wave of wavelength 375 m?

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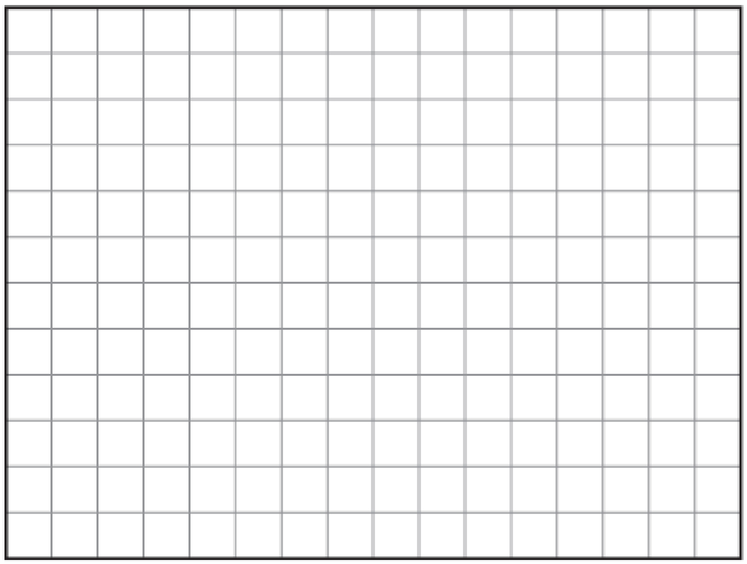
3. In an experiment with electric circuits the following data was recorded. Plot a graph with the data:



Current (A)	**Power** (W)
1.0	1.0
2.5	6.5
4.0	16.2
5.0	25.8
7.0	50.2
8.5	72.0

a. What kind of curve did you obtain?

b. What is the relationship between the variables?

c. What is the power when the current is 3.2 A?

d. What is the current when the power is 64.8 W?

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Part VI Solving quadratic equations:
Solve each of the following quadratic equations. Obtain your answers in surd, not decimal, form.

1. $x^2 + 8x + 1 = 0$	**2.** $x^2 + 7x - 2 = 0$	**3.** $x^2 + 6x - 2 = 0$
4. $4x^2 + 3x - 2 = 0$	**5.** $2x^2 + 3x - 1 = 0$	**6.** $x^2 + x - 1 = 0$
7. $-x^2 + 3x + 1 = 0$	**8.** $-2x^2 - 3x + 1 = 0$	**9.** $2x^2 + 5x - 3 = 0$
10. $-2s^2 - s + 3 = 0$	**11.** $9x^2 + 16x + 1 = 0$	**12.** $x^2 + 16x + 9 = 0$

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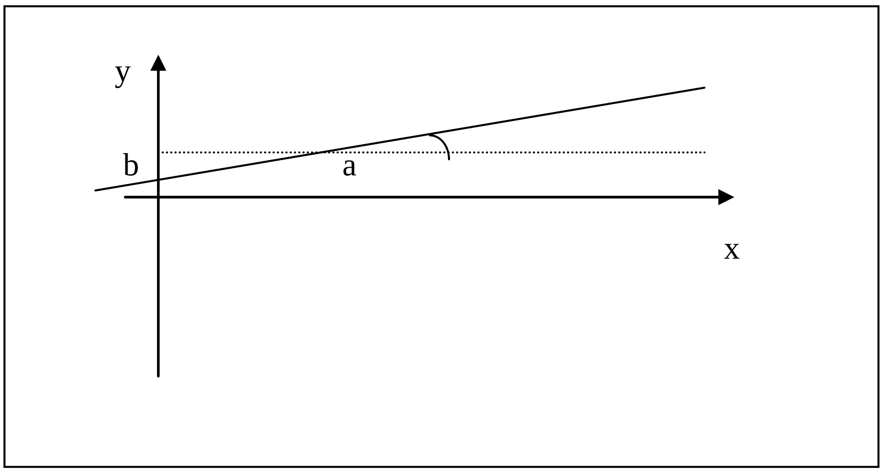
Part VII Graphs

Types of graphs

Graphs are VERY important in physics because they show patterns between variables. A straight line graph that starts from the (0,0) point is the best proof that two variables are directly proportional.

Straight line graph

You should know from your math that the general equation for a straight line is $y = ax + b$, where a is the gradient of the graph and b is the point that the line cuts the y-axis.



You must also know from your maths the equation for a hyperbola, a parabola, an ellipse etc. Make your own table including all the graph shapes you know and their functions. Make sure you include the logarithmic and exponential functions. Search on line to find examples in Physics.

Function	Graph	Example in physics
$y = ax + b$		

Name

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How to choose the right graph for plotting

Although the above list is important, when it comes to finding a relationship between two variables the only graph that can show this very clearly is the straight line graph.

EXAMPLE

Let's say that you want to prove the relationship between the kinetic energy of an object and its velocity. You plot velocity on the x-axis and kinetic energy on the y-axis. You will get a curve which as you now is a parabola (since the kinetic energy is directly proportional to the square of the velocity).

Now let's say you do another experiment that, unknown to you, also follows the same pattern. You will also get a curve when you plot the graph. Will you be able to recognize that this is a parabola? What if it is a curve that is very close to a parabola but not quite?

What can you do to be sure that you have cracked the relationship?

Think again about the example above. If instead of plotting kinetic energy against velocity you plot kinetic energy against velocity **squared** what will you get? You will get a straight line through zero! Moreover, you will be certain that the relationship is that: the kinetic energy is directly proportional to the velocity squared.

So what have we learned so far?

ALWAYS AIM AT PLOTTING TWO VARIABLES THAT WILL GIVE YOU A STRAIGHT LINE!

Here are some examples:

- To prove that resistance R is inversely proportional to cross sectional area A, plot R against $\frac{1}{A}$. This should give you a straight line.
- To prove that the square of the period T of a pendulum is directly proportional to its length l plot either T^2 against l or T against $\sqrt{l}$

NOW TRY THIS!

1. The pendulum equation is:

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

a) What variables should you plot against each other in order to prove that the period of the pendulum does not depend on its mass? What will the shape of this graph be?

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b) What variables should you plot against each other to prove that the period depends on the gravitational field strength as shown by the equation?

2. The universal gravitational law is given by the equation:

$$F = -G\frac{mM}{r^2}$$

a) What variables should you plot against each other in order to prove that the attractive force (F)is directly proportional to both masses (mM) of the objects?

b) What variables should you plot against each other in order to prove that the attractive force is inversely proportional to the distance squared (r^2) between the objects?

The significance of the gradient

During your coursework you will be asked to decide which graphs to plot in order to show a relationship or to calculate a physical constant.
We have already noted how important it is to aim at plotting a graph that will end up being a straight line. This gives you a definite answer about the relationship between the two variables. But there is more to it. The gradient of this line will give you information about a constant in your experiment.
EXAMPLE
Let's say that you want to measure the gravitational field strength of Earth with a pendulum. You vary the length and measure the period. You then decide to plot T^2

against l . The graph will be a straight line. What will its gradient be? To find this, compare the pendulum equation with the straight line equation as shown below:

$$T^2 = 4\pi^2 \frac{l}{g}$$
$$y = ax + b$$

I hope you can see that y corresponds to T^2, x corresponds to l , b corresponds to zero, and a corresponds to $\frac{4\pi^2}{g}$. This tells you that once you measure the gradient from your graph you will know the value of $\frac{4\pi^2}{g}$ and you will then be able to calculate g from this as:

$$gradient = \frac{4\pi^2}{g} \Rightarrow g = \frac{4\pi^2}{gradient}$$

NOW TRY THIS!

Try to find the gradient in all the situations listed below. The first three have been done for you.

Equation	Plot y against x	gradient	Constant
$R = \frac{V}{I}$	$x - axis : current$ $y - axis : voltage$	$gradient = R$	(for a fixed R resistor)
$R = \frac{V}{I}$	$x - axis : voltage$ $y - axis : current$	$gradient = \frac{1}{R}$	(for a fixed R resistor)
$E = \frac{\frac{F}{A}}{\frac{x}{l}}$	$x - axis : force$ $y - axis : extension$	$gradient = \frac{l}{EA}$	$E = \frac{l}{A \times gradient}$ (Young's modulus)
$R = \frac{\rho L}{A}$	$x - axis : L$ $y - axis : R$	$gradient =$	$\rho =$ (resistivity)
$R = \frac{\rho L}{A}$	$x - axis : \frac{1}{A}$ $y - axis : R$	$gradient =$	$\rho =$ (resistivity)
$\frac{1}{2}mv^2 = Fs$ (stopping distance-velocity relationship)	$x - axis : v^2$ $y - axis : s$	$gradient =$	$F =$ (fricition)

$xd = \lambda L$ (double slit interference)	$x - axis : \frac{1}{d}$ $y - axis : x$	$gradient =$	$\lambda =$ (wavelength)
$xd = \lambda L$ (double slit interference)	$x - axis : L$ $y - axis : x$	$gradient =$	$\lambda =$ (wavelength)

Apart from its use as explained above, the gradient in all lines (curved or straight) corresponds to the **derivative** of the function you plot. This is why if you plot time on the x-axis and displacement on the y-axis the gradient corresponds to the velocity of the object. If the line is curved the gradient does not stay the same, which means that it is equal to the instantaneous velocity of the object.

For the same reason if you plot time on the x-axis and velocity on the y-axis the gradient corresponds to the acceleration of the object. If the line is curved the gradient does not stay the same, which means that it is equal to the instantaneous acceleration of the object.

The significance of the area under a graph

The area between a graph of $y = f(x)$ and the x-axis is equal to the **definite integral** of the function. This formula gives a positive result for a graph above the x-axis, and a negative result for a graph below the x-axis. [9]

This is why the area under a velocity-time graph is equal to the distance covered by the object.

If the graph is a straight line then the area under can be calculated very precisely as the area of a triangle or trapezium etc. If the line is a curve, the area is often estimated to a good precision before it can give you some useful information.

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Part VIII Word problems

Have a look at these word problems and try to solve them.

Problem 1

Anna has 800 apples in baskets. Each basket holds 16 apples. How many baskets does she have?

Problem 2

John has 147 pears in 21 baskets. How many baskets does he need for 14 pears?

Problem 3

The weight of a 50.0 kg person on the moon is 80.0N. How much would a 72.0 kg person weigh on the moon?

Problem 4

When stereo sound information is transmitted through a cable, 32 bits are sent every 22.7μs. Calculate how many bits you can send during 2 seconds (2 s = 2 x 10^6 μs)

Introduction to Calculus Assignment

Watch and take detailed notes on the Introduction Video and Highlights of Calculus (5 Videos). Screenshot your notes and attach them to this document. The webite is listed below.

Big Picture of Calculus

There is also an online Textbook if you are interested