Summer Assignment AP Physics 1

Physics is the most basic of the sciences and was originally developed by Sir Isaac Newton. Physics attempts to describe the universe using mathematical relationships and basic concepts. Due to the symbolic nature of the equations and concepts, physics can be a challenging course. To learn physics means that one must re-learn their everyday experiences in light of some non-intuitive rules, since the rules of motion on our planet are influenced by gravity, air resistance, and friction. Students must be able to learn the rules beneath their everyday experiences and apply them to a variety of situations. This course will involve a lot of lab activities and hands-on experimentation in order to measure, compare, and fit results to mathematical equations. The course does not require math above Algebra II, but higher math courses will be referenced in explaining some results.

In order to be prepared for this challenging and fast paced course, I have put together a summer assignment package for you to work on. The idea behind this packet is to make sure you practice some of the math and concepts that you will need to use in physics. The best way to approach the problems in this packet would be to make sure and do a few of them each week of summer. That way you will keep math fresh in your mind and will not have a drop-off before we return in fall. Alternatively, you could do this packet two weeks before school starts to get yourself back up to speed at the end of summer. Either way, this packet will be essential to make sure that you come prepared for physics class when school resumes.

In addition to the problems, this packet also directs you to watch some introductory videos on some of the same physics topics. Watching videos and taking notes will be a regular occurrence in class, since videos are often assigned as homework – a way to introduce the ideas and concepts before they are explicitly taught in class.

I am excited to get to teach my favorite science course and hope that you will be excited to learn. This class will require a lot of extra time, since it is taught at a college level. The only way to learn this science is through experimentation, working problems, and correcting mistakes. Be ready to make mistakes – but hopefully not repeat them. Science is all about using mistakes to get things right! The more you think about physics, especially as you go about your daily life, the better you will understand it. Please give this packet your attention over the summer, <u>there will be a quiz using some of these exact problems the first day of class – so be warned and be ready!</u>

Enjoy Your Summer

Mr. Finger

Algebraic Manipulations

While getting a number is a good skill to have and one, we will utilize a lot, it is more crucial that we can manipulate an equation. Often, a deeper understanding of the concept can come from analyzing the variables and their relation to one another rather than simply plugging in the values and evaluating a single answer.

Solve each equation symbolically for the indicated variable. Show all of you work.

1. $v = \frac{\Delta x}{\Delta t}$ (solve for Δt)

2. $y = y_0 + v_0 t + \frac{1}{2} a t^2$ (solve for **a**)

3. $F = ma$ (solve for a)

4. $F\Delta t = mv$ (solve for v)

5. $F_s = T - mg$ (solve for m)

6. $P = \frac{V^2}{R}$(solve for R)

7. $K = \frac{1}{2} m v^2$ (solve for v)

8. $a_{cp} = \frac{v^2}{r}$ (solve for v)

9. $f = \frac{1}{T}$ (solve for T)

10. $T = 2\pi\sqrt{\frac{l}{g}}$ (solve for l)

11. $v^2 = v_0^2 + 2a(d - d_0)$ (solve for v_0)

12. $F_e = \frac{Kq_a q_b}{r^2}$ (solve for r)

2. **Solving Equations:**

Often problems on the AP exam are done with variables only. Solve for the variable indicated. Don't let the different letters confuse you. Manipulate them algebraically as though they were numbers.

a. $K = \frac{1}{2}kx^2$, $x =$ ____________

b. $T_p = 2\pi\sqrt{\frac{\ell}{g}}$, $g =$ ____________

c. $F_g = G\frac{m_1 m_2}{r^2}$, $r =$ ____________

d. $mgh = \frac{1}{2}mv^2$, $v =$ ____________

e. $x = x_o + v_o t + \frac{1}{2}at^2$, $t =$ ____________

f. $B = \frac{\mu_o}{2\pi}\frac{I}{r}$, $r =$ ____________

g. $x_m = \frac{m\lambda L}{d}$, $d =$ ____________

h. $pV = nRT$, $T =$ ____________

i. $\sin\theta_c = \frac{n_1}{n_2}$, $\theta_c =$ ____________

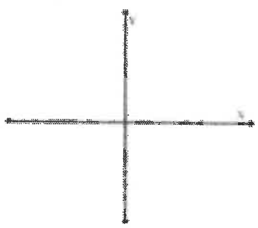
j. $qV = \frac{1}{2}mv^2$, $v =$ ____________

Graphing

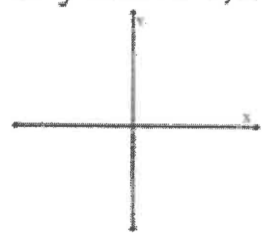
Being able to produce and analyze a graph using data given or collected in a lab is a skill that is often found in every topic in this course and on the exam. In this section you will encounter most likely a new topic that has not been taught before known as linearization, the process of taking data that does not yield a straight line of best fit and making it into one that does. I will walk you through this when we get to it in this assignment.

On the y vs x graphs below, sketch the relationships given

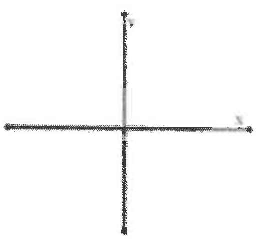
a. $y = mx + b$, if $m > 0$ and $b = 0$.



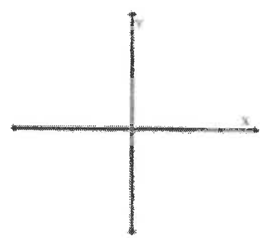
b. $y = mx + b$, if $m < 0$ and $b > 0$.



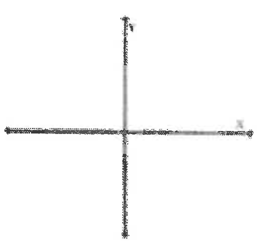
c. $y = x^2$



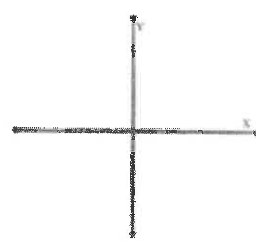
d. $y = \sqrt{x}$



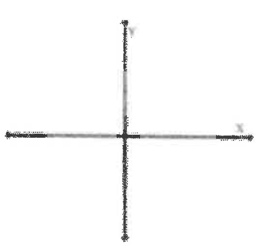
e. $y = 1/x$



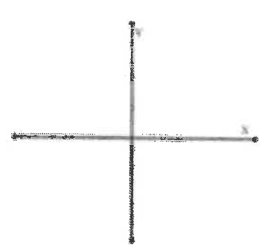
f. $y = 1/x^2$



g. $y = x^{1/2}$



h. $y = \sin(x)$



Part 4: Algebraic Skills

Section I

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

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

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

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

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

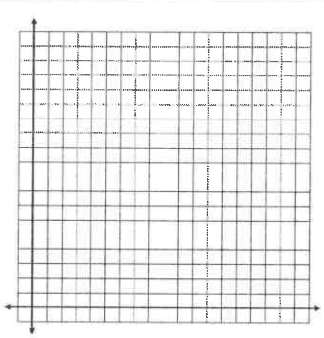
3) If m is doubled and T_S remains constant, what happens to k ? Explain.

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

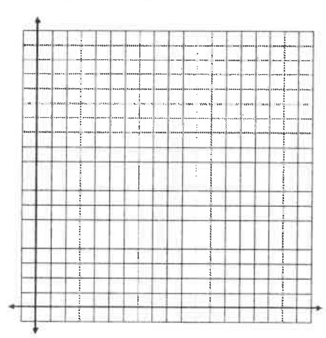
4) If m is tripled and k remains constant, what happens to T_S ? Explain.

5) On the graphs below, sketch[2] the following graphs to show the relationships. Label each axis with the correct variable and units. When a graph is written in the form y vs. x, the first term should go on the y-axis.

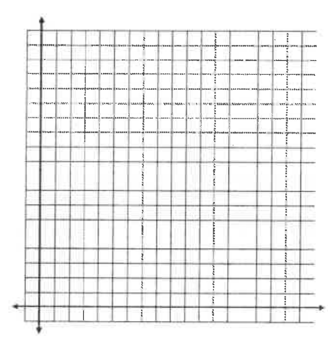
T vs. m



T vs. k

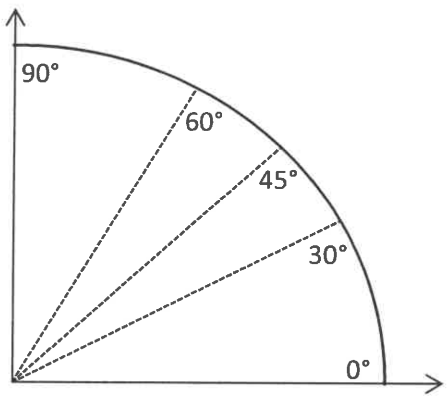


T^2 vs. m



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

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?

Vectors

Most of the quantities in physics are vectors. ***This makes proficiency in vectors extremely important***.

Magnitude: Size or extend. The numerical value.

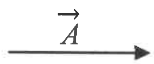
Direction: Alignment or orientation of any position with respect to any other position.

Scalars: A physical quantity described by a single number and units. A quantity described by **magnitude only**.

Examples: time, mass, and temperature

Vector: A physical quantity with **both a magnitude and a direction**. A directional quantity.

Examples: velocity, acceleration, force

Notation: $\vec{A}$ or 

Length of the arrow is proportional to the vectors magnitude.
Direction the arrow points is the direction of the vector.

Negative Vectors

Negative vectors have the same magnitude as their positive counterpart. They are just pointing in the opposite direction.

Vector Addition and subtraction

Think of it as vector addition only. The result of adding vectors is called the resultant. $\vec{R}$

$\vec{A}+\vec{B}=\vec{R}$

So if ***A*** has a magnitude of 3 and ***B*** has a magnitude of 2, then ***R*** has a magnitude of 3+2=5.

When you need to subtract one vector from another think of the one being subtracted as being a negative vector. Then add them.

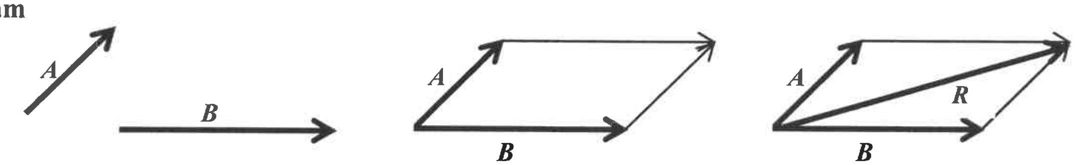
A negative vector has the same length as its positive counterpart, but its direction is reversed.
So if ***A*** has a magnitude of 3 and ***B*** has a magnitude of 2, then ***R*** has a magnitude of 3+(-2)=1.

This is very important. In physics a negative number does not always mean a smaller number. Mathematically –2 is smaller than +2, but in physics these numbers have the same magnitude (size), they just point in different directions (180° apart).

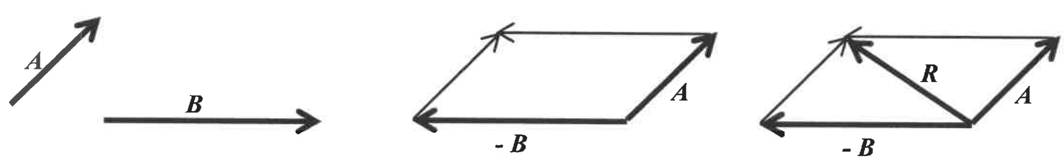
There are two methods of adding vectors

Parallelogram

A* + *B

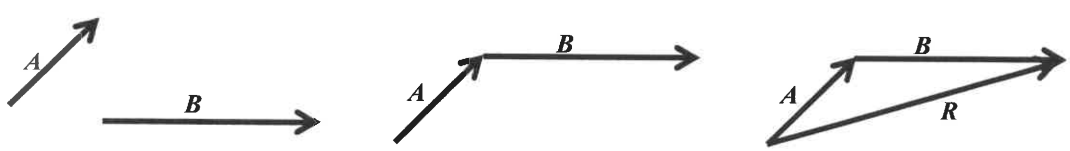


A* – *B

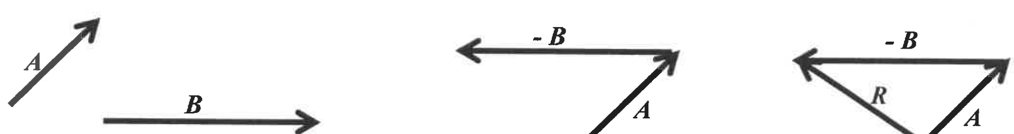


Tip to Tail

A* + *B



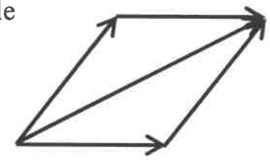
A* – *B



6. Drawing Resultant Vectors

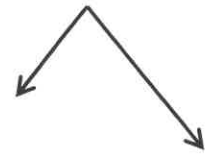
Draw the resultant vector using the parallelogram method of vector addition.

Example



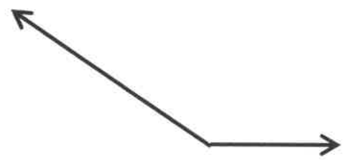
b.

d.

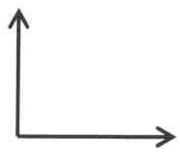


a.

c.

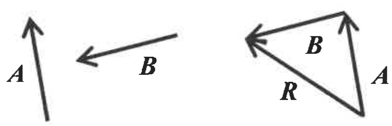


e.

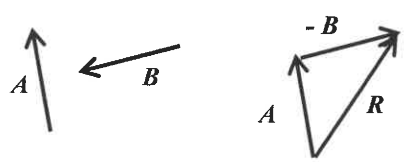


Draw the resultant vector using the tip to tail method of vector addition. Label the resultant as vector ***R***

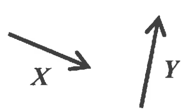
Example 1: ***A*** + ***B***



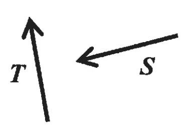
Example 2: ***A*** – ***B***



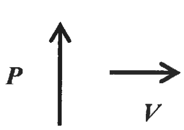
f. ***X*** + ***Y***



g. ***T*** – ***S***



h. ***P*** + ***V***

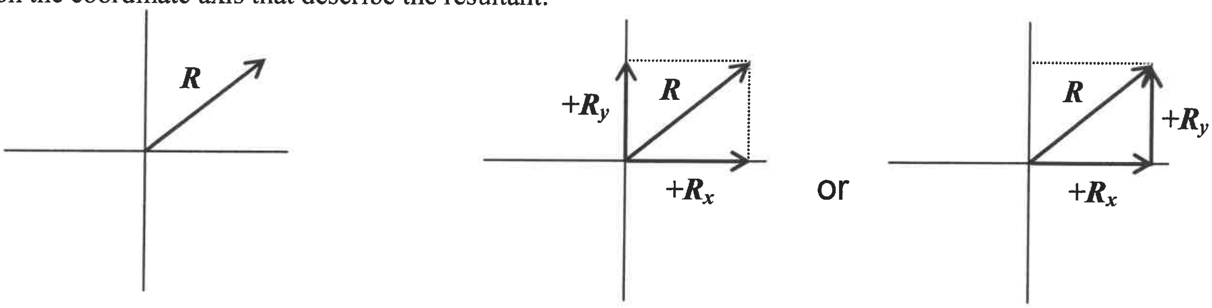


i. ***C*** – ***D***

Component Vectors

A resultant vector is a vector resulting from the sum of two or more other vectors. Mathematically the resultant has the same magnitude and direction as the total of the vectors that compose the resultant. Could a vector be described by two or more other vectors? Would they have the same total result?

This is the reverse of finding the resultant. You are given the resultant and must find the component vectors on the coordinate axis that describe the resultant.

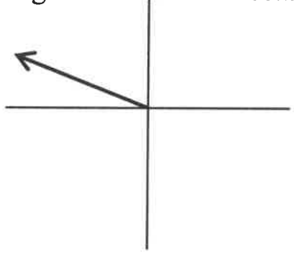


Any vector can be described by an *x* axis vector and a *y* axis vector which summed together mean the exact same thing. The advantage is you can then use plus and minus signs for direction instead of the angle.

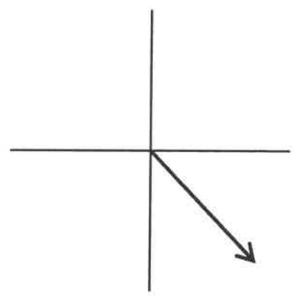
7. Resolving a vector into its components

For the following vectors draw the component vectors along the *x* and *y* axis.

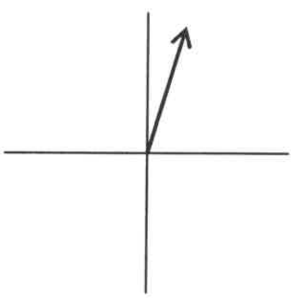
a.



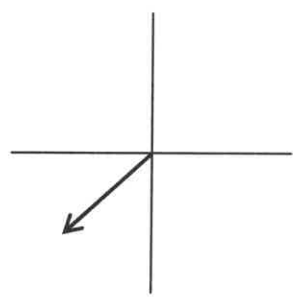
c.



b.



d.



Obviously the quadrant that a vector is in determines the sign of the *x* and *y* component vectors.

AP Physics 1 – Summer Assignment - Videos

Please watch the following videos and take brief notes on them in order to give proof that you have watched them. The videos that I am assigning are part of a larger group of videos that cover all of the AP Physics 1 content. If you like the videos you may refer to them at any time during the school year for supplemental information (the videos for homework during the school year will be from the College Board). Each video is short, usually under 10 minutes.

Video 1 – Working with Significant Figures
https://www.flippingphysics.com/working-with-significant-figures.html

Video 2 – Introduction to Base Units
https://www.flippingphysics.com/introduction-to-base-dimensions.html

Video 3 – Review SOHCAHTOA
https://www.flippingphysics.com/review-soh-cah-toa-and-the-pythagorean-theorem.html

Video 4 – Introduction to Displacement
https://www.flippingphysics.com/introduction-to-displacement.html

Video 5 – Introduction to Velocity and Speed
https://www.flippingphysics.com/introduction-to-velocity-and-speed.html

Video 6 – Introduction to Acceleration
https://www.flippingphysics.com/introduction-to-acceleration-with-prius-brake-slamming-example-problem.html

Video 7 – Introduction to Free-Fall
https://www.flippingphysics.com/introduction-to-free-fall.html

Video 8 – Introduction Vectors and Scalars
https://www.flippingphysics.com/vectors-and-scalars.html

Video 9 – Introduction Tip-to-Tail Vector Addition
https://www.flippingphysics.com/tip-to-tail-vector-addition.html

Video 10 – Cardinal Directions
https://www.flippingphysics.com/cardinal-directions.html

Video 11 – Vector Components
https://www.flippingphysics.com/vector-components.html

Video 12 – Vector Addition with Components
https://www.flippingphysics.com/introductory-vector-addition-problem.html