AP Physics C- Mechanics

Summer Assignment

Name ______________________________

Date ________________

The summer assignment consists of three parts:

I. Email Mrs. Heyes at heyesd@calvertnet.k12.md.us and let her know how your summer is going. Then I'll email you back with information for signing up for the class "Remind". Estimated time for completion: 15 minutes.

II. **Vector Review and Intro to Basic Calculus:** Of all the Physics classes taught at HHS, this one is the most in depth and demanding mathematically. It is imperative that students have mastered vectors, how to find resultants, how to decompose them, etc. Vector dot and cross products and some introductory calculus will be taught the first couple of weeks of school. Attached are vector and calculus problems for you to complete. Estimated time for completion: 4 ½ hours.

What if I don't get all the problems or don't understand the instructions?

A. Do the best you can. You ***must*** show some work / effort in order to receive credit.

B. Come to class the first day with your questions, in order to resolve these issues prior to the test.

C. The packet is due the second day of class.

III. **Read the first three chapters of "Six Easy Pieces. Essentials of Physics Explained by its Most Brilliant Teacher." by Richard Feynman.** The book is available used from many online stores for approximately $6.00- to $10.00, including shipping. It's also available on Kindle. The book's ISBN # is 978-0-465-02527-5. Or you may contact Mrs. Heyes during the summer. She has a few copies of the book and if they aren't all lent out, you may be able to borrow it. Then answer any 3 of the 6 following questions in paragraph form. One or two paragraphs should suffice for each answer. Email/share your document to me (heyesd@calvertnet.k12.md.us) with the filename APCSumAssnLastnameFirstinitial to me by the day before school starts. Estimated time for completion: 4 hours.

1. In Chapter One, Dr. Feynman describes a number of physical processes at the atomic level. Describe how his description applies to a physical process you have learned about previously in a science class.

2. Also in Chapter One, Dr. Feynman describes the causes of Brownian Motion. Give a brief history of our knowledge of Brownian Motion and relate your understanding of particle collisions to Brownian Motion.

3. Chapter Two describes physics from the view point of traditional (“Newtonian”) versus Quantum Physics. Compare and contrast physics from the point of view of a physicist working before versus after 1920.

4. This book is a compilation of lectures given by Dr. Feynman at CalTech from 1961 to 1963. A lot has changed in physics since then! Just recently (July 2012), researchers at the LHC in CERN announced they have found the long sought after Higgs Boson particle. In Chapter 2, Feynman gives a table of known particles and classifies them as Baryons, Mesons, and Leptons. Find an online source (or sources) that lists currently known particles and compare it to Dr. Feynman’s list from the early 1960’s. What’s new? What’s the same? What was there in 1963 but our understanding of it has been refined?

5. In Chapter Three, Feynman relates physics to other science disciplines. Again, because the book was originally published over 50 years ago, some of what he says is no longer true. Choose a case in which Feynman states a limitation in a field that is no longer a limitation and discuss the gains in knowledge that have occurred in the last 50 years.

6. When discussing meterology, Feynman states that we cannot predict the weather accurately. That is still true, however much effort has been put into making computer based meterological models to predict storms. Brainstorm some physical parameters that one would have to include in a weather prediction model, and discuss why they would make weather prediction so difficult.

VECTORS (Estimated time to complete this section: 2 hours)

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

Magnitude: Size or extent. 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 $\xrightarrow{\quad \vec{A} \quad}$ 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.

$\xrightarrow{\quad \vec{A} \quad}$ $\xleftarrow{\quad -\vec{A} \quad}$

Vector Addition and subtraction

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

$\vec{A}+\vec{B}=\vec{R}$ $\xrightarrow{\quad \vec{A} \quad}$ + $\xrightarrow{\ \vec{B}\ }$ = $\xrightarrow{\qquad \vec{R} \qquad}$

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.

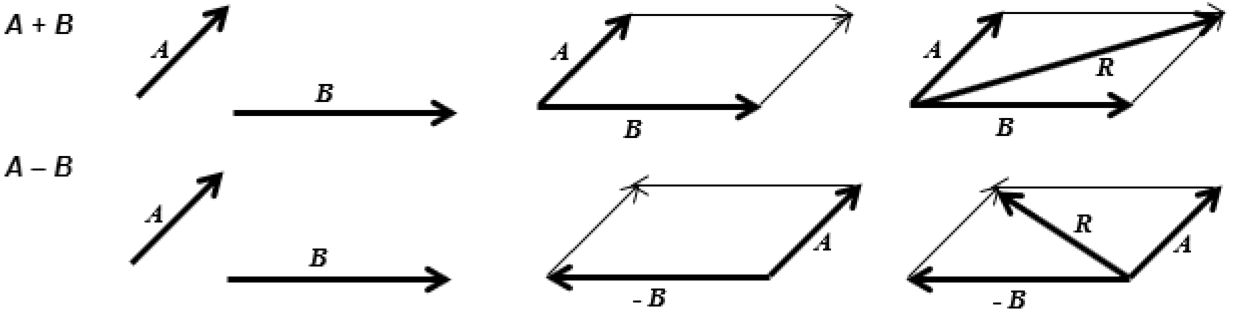
$\vec{A}+\vec{B}$ is really $\vec{A}+-\vec{B}=\vec{R}$ $\xrightarrow{\quad \vec{A} \quad}$ + $\xleftarrow{\ -\vec{B}\ }$ = $\xrightarrow{\vec{R}}$

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^{o} apart).

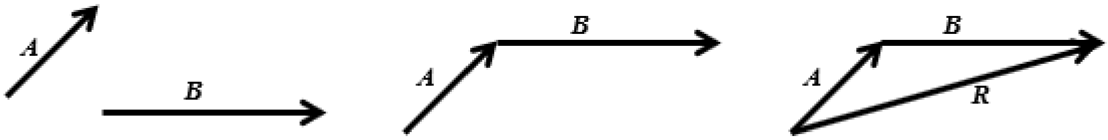
There are two methods of adding vectors

Parallelogram

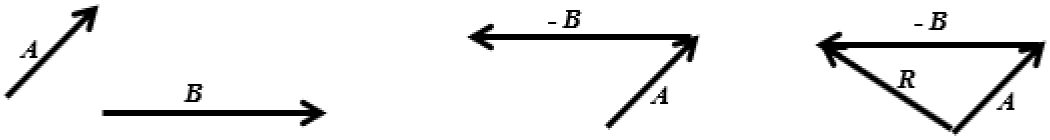


Tip to Tail

A + *B*



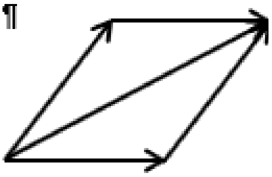
A – *B*



It is readily apparent that both methods arrive at the exact same solution since either method is essentially a parallelogram. It is useful to understand both systems. In some problems one method is advantageous, while in other problems the alternative method is superior.

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

Example¶

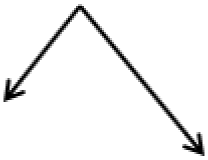


a. → ¶

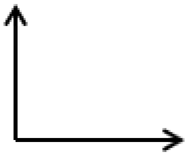
b. → ¶

c. → ¶

d.

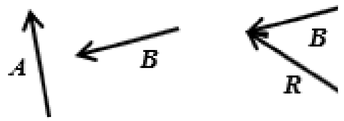


e.

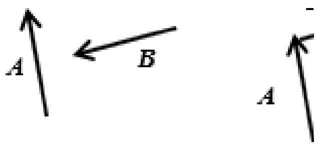


2. Draw the resultant vector using the tip to tail method of vector addition. Label the resultant as vector ***R***

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

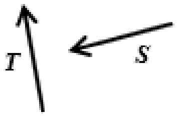


Example 2: ***A*** – ***B***

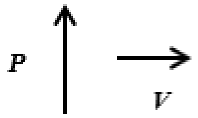


a. ***X*** + ***Y***

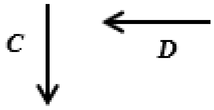
b. ***T*** – ***S***



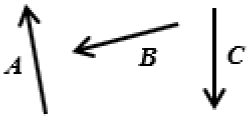
c. ***P*** + ***V***



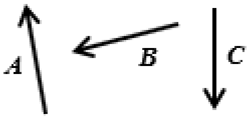
d. C – ***D***



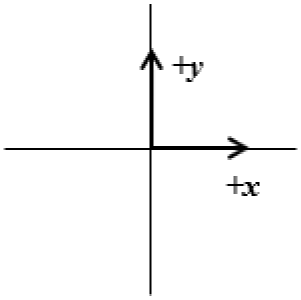
e. ***A*** + ***B*** + C

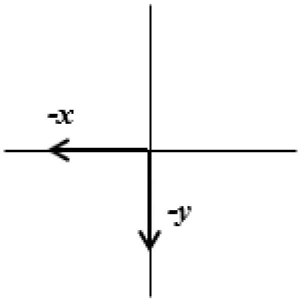


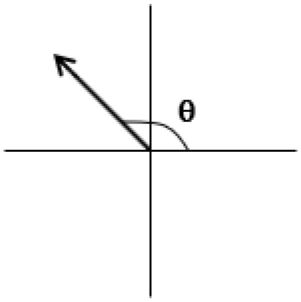
f. ***A*** – ***B*** – C



Direction: What does positive or negative direction mean? How is it referenced? The answer is the coordinate axis system. **In physics a coordinate axis system is used to give a problem a frame of reference.** Positive direction is a vector moving in the positive ***x*** or positive ***y*** direction, while a negative vector moves in the negative ***x*** or negative ***y*** direction (This also applies to the ***z*** direction).





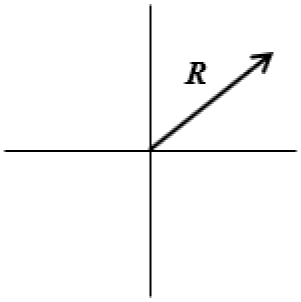


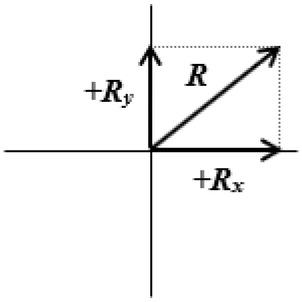
What about vectors that don't fall on the axis? We will specify their direction using degrees measured from East.

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.





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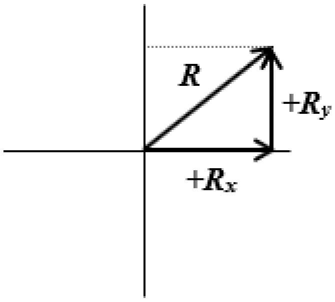
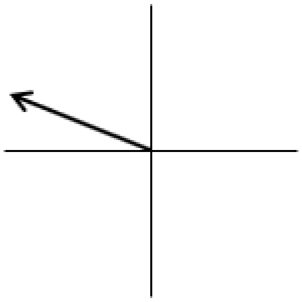


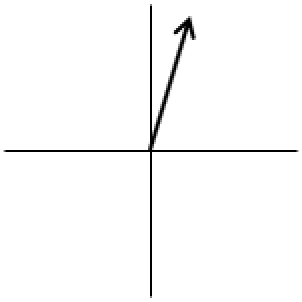
Any vector can be described by an ***x*** axis vector and a ***y*** axis vector which summed together mean the exact same thing. The advantage is you can then use plus and minus signs for direction instead of the angle.

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

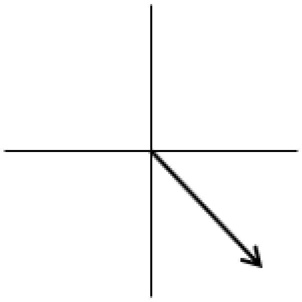
a.



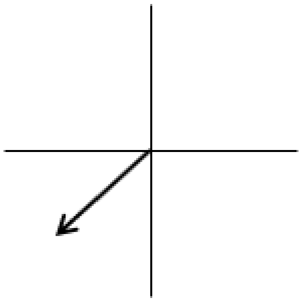
b.



c.



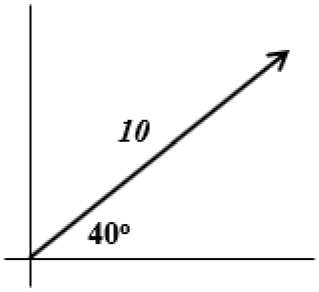
d.

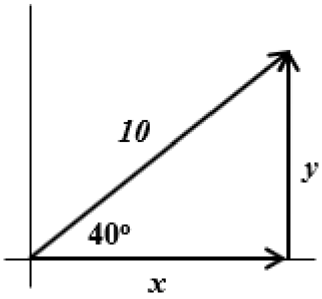


Obviously the quadrant that a vector is in determines the sign of the ***x*** and ***y*** component vectors.

Trigonometry and Vectors

Given a vector, you can now draw the ***x*** and ***y*** component vectors. The sum of vectors ***x*** and ***y*** describe the vector exactly. But, how do you mathematically find the length of the component vectors? Use trigonometry.





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

$adj = hyp\cos\theta$ $opp = hyp\sin\theta$

$x = hyp\cos\theta$ $y = hyp\sin\theta$

$x = 10\cos 40^\circ$ $y = 10\sin 40^\circ$

$x = 7.66$ $y = 6.43$

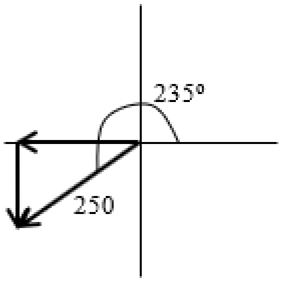
4. Solve the following problems. You will be converting from a polar vector, where direction is specified in ***degrees measured counterclockwise from east***, to component vectors along the ***x*** and ***y*** axis. Remember the plus and minus signs on you answers. They correspond with the quadrant the original vector is in.

   Hint: Draw the vector first to help you see the quadrant. Anticipate the sign on the ***x*** and ***y*** vectors. Do not bother to change the angle to less than 90°. Using the number given will result in the correct + and – signs.

   The first number will be the magnitude (length of the vector) and the second the degrees from east.

   Your calculator must be in degree mode.

Example: 250 at 235°



$x = hyp\cos\theta$

$x = 250\cos 235^\circ$

$x = -143$

$y = hyp\sin\theta$

$y = 250\sin 235^\circ$

$y = -205$

a. 89 at 150°

b. 6.50 at 345°

c. 0.00556 at 60°

d. 7.5x10⁴ at 180°

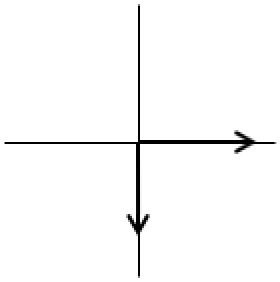
e. 12 at 265°

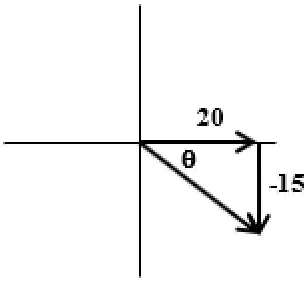
f. 990 at 320°

g. 8653 at 225°

5. Given two component vectors solve for the resultant vector. This is the opposite of number 11 above. Use Pythagorean Theorem to find the hypotenuse, then use inverse (arc) tangent to solve for the angle.

Example: ***x*** = 20, ***y*** = -15





$$R^2 = x^2 + y^2 \qquad \tan\theta = \frac{opp}{adj}$$

$$R = \sqrt{x^2 + y^2} \qquad \theta = \tan^{-1}\left(\frac{opp}{adj}\right)$$

$$R = \sqrt{20^2 + 15^2} \qquad \theta = \tan^{-1}\left(\frac{y}{x}\right)$$

$$R = 25$$

$$\theta = \tan^{-1}\left(\frac{-15}{20}\right) = -36.9^\circ$$

$$360^\circ - 36.9^\circ = 323.1^\circ$$

a. ***x*** = 600, ***y*** = 400

d. ***x*** = 0.0065, ***y*** = -0.0090

b. ***x*** = -0.75, ***y*** = -1.25

e. ***x*** = 20,000, ***y*** = 14,000

c. ***x*** = -32, ***y*** = 16

f. ***x*** = 325, ***y*** = 998

Calculus Review **What math will you be in this fall?** ____________________

Estimated time to complete this section: 2 ½ hours.

Watch the following videos and complete the problems below to the best of your ability.
http://arapahoehsphysics.blogspot.com/2013_05_01_archive.html .

If you have no calculus background whatsoever, watch them in this order: Derivatives and Power Rule, Chain rule and product rule, Other common derivatives, Derivatives and max/min, Definite integrals, Indefinite integrals. You might want to watch them twice and take notes. Do your best. If you are in Calc AB this coming fall you might not be able to do all of this, but you should at least try. You have a year to master it before the AP test ☺

Find the derivative of each of the following functions and simplify.

1. $f(x) = 4x^2 – 6$
2. $f(x) = 5x^3 − 3x$
3. $f(x) = 4x^3 − 3x^2 + 2x – \pi$
4. $f(x) = −3(2x^2 − 5x + 1)$
5. $f(x) = (3x − 2)(2x + 1)$

Find the antiderivative (integral) of each of the following.

1. $\int 3x^2 + 2x + 1)dx$
2. $\int 5x - x^5 + 8)dx$
3. $\int(\sqrt{x} + x^{2/3} + \frac{x^2}{x^{1/3}} dx$
4. $\int(sinx - cosx)dx$
5. $\int \frac{1}{x} dx$

A ball is thrown into the air (vertically) from a height of 10 m and an initial velocity of 3 m/s
If the formula that represents the height (displacement) of the ball is $h = -4.9t^2 + 3t + 10$

a. What is the velocity of the ball when it hits the ground? (Hint: find t first)

b. At what time will the ball reach its maximum height?

c. What is the acceleration of the ball 0.3 s after it is thrown?