Name:________________________

AP Physics 1 SUMMER ASSIGNMENT

Welcome

Welcome to AP Physics 1 at Hardin Valley academy. For many of you, this will be your first full physics course. Fortunately, we will cover many of the concepts that were covered your freshman year in Physical World Concepts. One difference, however, will be the pace and the mathematical rigor.

One thing that you will quickly notice in this course is that the language of physics is mathematics. Physics is in essence the study of turning observations of the universe around us into mathematical models which can be used to predict the outcomes of physical events. As such, we need to be on a firm mathematical footing for this course. AP Physics 1 is not calculus based, and the co-requisite is Precalculus. This packet will help you brush up on the skills that you will need for this course so that we can concentrate on the models themselves rather than the mechanics of how to solve them.

This packet will be due on the first day of class. It seems long, but there is plenty of time to do it all without having to spend much time a day if the work is spread out over time.

I look forward to seeing you in my physics class!

Dr. Sternberg

SECTION ONE: Working with Equations / Scientific Notation

1. The following are ordinary physics problems. Place the answer in scientific notation when appropriate and simplify the units (Scientific notation is used when it takes less time to write than the ordinary number does. As an example 200 is easier to write than $2.00\text{x}10^2$, but $2.00\text{x}10^8$ is easier to write than 200,000,000). Do your best to cancel units, and attempt to show the simplified units in the final answer.

a. $T_s = 2\pi\sqrt{\dfrac{4.5\times10^{-2}\,kg}{2.0\times10^{3}\,kg/s^2}} =$ ________________

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

c. $F = \left(9.0\times10^{9}\ \dfrac{N\cdot m^2}{C^2}\right)\dfrac{\left(3.2\times10^{-9}C\right)\left(9.6\times10^{-9}C\right)}{\left(0.32m\right)^2} =$ ________________

d. $\dfrac{1}{R_p} = \dfrac{1}{4.5\times10^{2}\Omega} + \dfrac{1}{9.4\times10^{2}\Omega}$ $R_P =$ ________________

e. $e = \dfrac{1.7\times10^{3}\ J - 3.3\times10^{2}\ J}{1.7\times10^{3}\ J} =$ ________________

f. $1.33\sin 25.0^\circ = 1.50\sin\theta$ $\theta =$ ________________

g. $K_{max} = \left(6.63\times10^{-34}\,J\cdot s\right)\left(7.09\times10^{14}\,s\right) - 2.17\times10^{-19}\,J =$ ________________

h. $\gamma = 1\Big/\sqrt{1-\dfrac{2.25\times10^{8}\,m/s}{3.00\times10^{8}\,m/s}} =$ ________________

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.

i. $v^2 = v_o{}^2 + 2a(s - s_o)$, $a =$ ______________

j. $K = \frac{1}{2}kx^2$, $x =$ ______________

k. $T_p = 2\pi\sqrt{\frac{\ell}{g}}$, $g =$ ______________

l. $F_g = G\frac{m_1 m_2}{r^2}$, $r =$ ______________

m. $mgh = \frac{1}{2}mv^2$, $v =$ ______________

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

o. $B = \frac{\mu_o}{2\pi}\frac{I}{r}$, $r =$ ______________

p. $x_m = \frac{m\lambda L}{d}$, $d =$ ______________

q. $pV = nRT$, $T =$ ______________

r. $\sin\theta_c = \frac{n_1}{n_2}$, $\theta_c =$ ______________

s. $qV = \frac{1}{2}mv^2$, $v =$ ______________

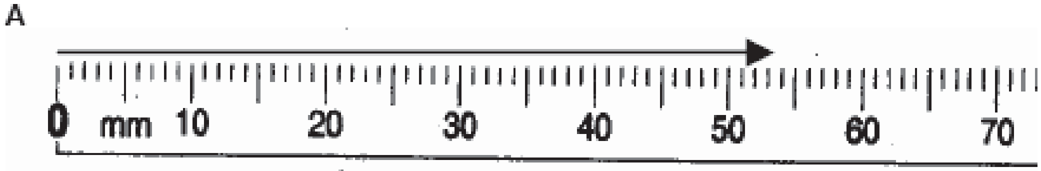
t. $\frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i}$, $s_i =$ ______________

SECTION TWO: Measurements

When using a measuring device, you **MUST** estimate between the smallest marks on the instrument. For example, if a ruler is marked off in increments of whole millimeters, you estimate the length of an object to the closest tenth of a millimeter.

Use the ruler below to measure the length of the arrow. Remember to estimate between the smallest marks.

Arrow A



The length of the arrow is __________ mm.

SECTION THREE: Units

Science uses the ***KMS*** system (***SI***: System Internationale). ***KMS*** stands for kilogram, meter, second. These are the units of choice of physics. The equations in physics depend on unit agreement. So you must convert to ***KMS*** in most problems to arrive at the correct answer.

There are two categories of unit conversions: [1] Converting with SI prefixes & [2] converting to different unit scales

[1]

kilometers (*km*) to meters (*m*) and meters to kilometers

centimeters (*cm*) to meters (*m*) and meters to centimeters

millimeters (*mm*) to meters (*m*) and meters to millimeters

nanometers (*nm*) to meters (*m*) and metes to nanometers

gram (*g*) to kilogram (*kg*)

[2]

Celsius (^oC) to Kelvin (*K*)

atmospheres (*atm*) to Pascals (*Pa*)

liters (*L*) to cubic meters (m^3)

PREFIXES		
Factor	Prefix	Symbol
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

[1] One Simple Method for Converting SI Prefixes:

Where you see the prefix, simply replace with the exponential notation of the number.

Example:

600 nm

from above chart n → nano → 10^{-9}

600×10^{-9} m

[2] Factor Label Method for Converting Units:

Similar to stoichiometry!

Example: 150 yards to inches

$$\frac{150\ \cancel{yards}}{} \times \frac{3\ \cancel{feet}}{1\ \cancel{yards}} \times \frac{12\ inches}{1\ \cancel{foot}} = \frac{5400}{1} = 5400\ inches$$

What if you don't know the conversion factors? Colleges want students who can find their own information (so do employers). Hint: Try a good dictionary and look under "measure" or "measurement". Or the Internet? Enjoy.

a. 4008 *g* = _______________ *kg*

b. 1.2 *km* = _______________ *m*

c. 823 *nm* = _______________ *m*

d. 298 *K* = _______________ ^oC

e. 0.77 *m* = ________________ *cm*

f. $8.8x10^{-8}$ *m* = ________________ *mm*

g. 1.2 *atm* = ________________ *Pa*

h. 25.0 *μm* = ________________ *m*

i. 2.65 *mm* = ________________ *m*

j. 8.23 *m* = ________________ *km*

k. 5.4 *L* = ________________ m^3

l. 40.0 *cm* = ________________ *m*

m. $6.23x10^{-7}$ *m* = ________________ *nm*

n. $1.5x10^{11}$ *m* = ________________ *km*

SECTION FOUR: Geometry Review

Solve the following geometric problems.

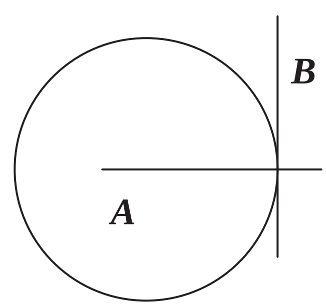
a. Line ***B*** touches the circle at a single point. Line ***A*** extends through the center of the circle.

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

 ____

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

 ____



b. What is angle ***C***?

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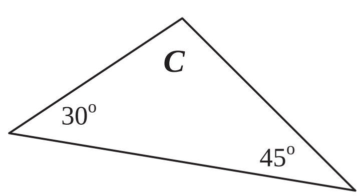
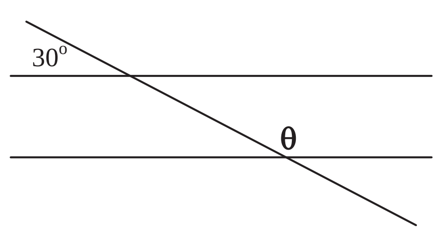


c. What is angle θ ?

____



d. How large is θ?

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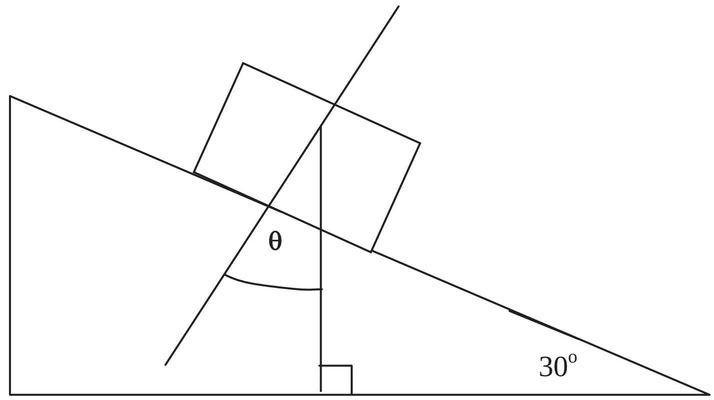


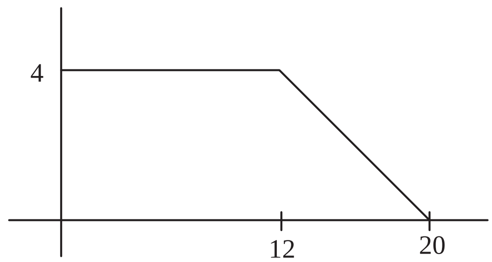
e. The radius of a circle is 5.5 *cm*,

i. What is the circumference in <u>meters</u>?

____

ii. What is its area in <u>square meters</u>?

____



f. What is the area under the curve at the right?

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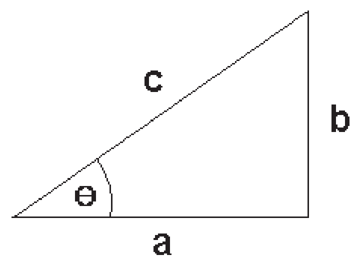
Using the generic triangle to the right, Right Triangle Trigonometry and Pythagorean Theorem solve the following. ***<u>Your calculator must be in degree mode.</u>***



a. $\theta = 55^o$ and $\boldsymbol{c}$ = 32 *m*, solve for $\boldsymbol{a}$ and $\boldsymbol{b}$.

c. $\boldsymbol{a}$ = 250 *m* and $\boldsymbol{b}$ = 180 *m*, solve for θ and $\boldsymbol{c}$.

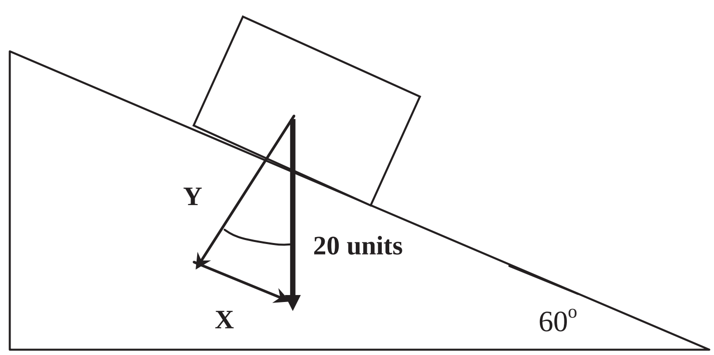
b. $\theta = 45^o$ and $\boldsymbol{a}$ = 15 *m/s*, solve for $\boldsymbol{b}$ and $\boldsymbol{c}$.

d. $\boldsymbol{a}$ =25 *cm* and $\boldsymbol{c}$ = 32 *cm*, solve for $\boldsymbol{b}$ and θ.

Use the image to the left to solve for the unknown values (this is a problem we will do again a few weeks into the semester when we discuss forces on inclined planes)

X = ____________________

Y = ____________________



SECTION FIVE: Graphical Analysis

You should be familiar with graph construction (by hand and on Excel). This is a topic that often appears on AP exams and is an easy way to score points on any assignment.

Note:
When you are told to graph Apples vs. Oranges, the 1st thing goes on the y-axis. The 2nd thing is on the x-axis.

Fill in the following table and plot the points on the grid below as distance versus time. Be sure to correctly label the graph (axes labels, including units, and title)

Time, t (s)	**Distance, d (m)**
0.0	0
1.0	5.1
2.0	9.9
3.0	15.2
4.0	25.2

Draw the best fit line through your data points.

Now use Excel to plot the graph. Record the equation of the best-fit line and R^2 value.

basics @ http://www.associatedcontent.com/video/14714/graphing_on_excel.html

(**Attach Excel graph to this packet or cut and tape in below**)

What is the slope of the line that you plotted (with correct units)?

insert graph here

SECTION SIX: Vectors

Most of the quantities in physics are vectors. ***<u>This makes proficiency in vectors extremely important</u>***.

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 **<u>magnitude only</u>**.
Examples: time, mass, and temperature

Vector: A physical quantity with **<u>both a magnitude and a direction</u>**. A directional quantity.
Examples: velocity, acceleration, force

Notation: $\vec{A}$ or $\xrightarrow{\quad\vec{A}\quad}$ <u>Length</u> of the arrow is <u>proportional to the vectors magnitude</u>.
<u>Direction</u> the arrow points <u>is the direction of the vector</u>.

Negative Vectors

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

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

Vector Addition and subtraction

Think of it as vector addition only. The result of adding vectors is called the <u>result</u>ant. $\vec{R}$

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

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

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).

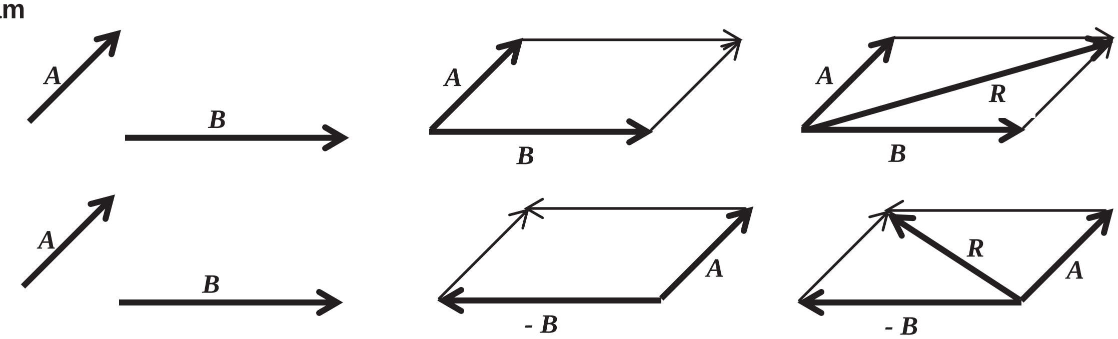
<u>Vectors in 2 dimensions</u>

There are two methods of adding vectors in 2 dimensions

Parallelogram

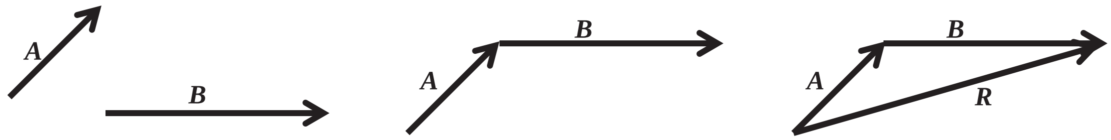
A* + *B

A* – *B

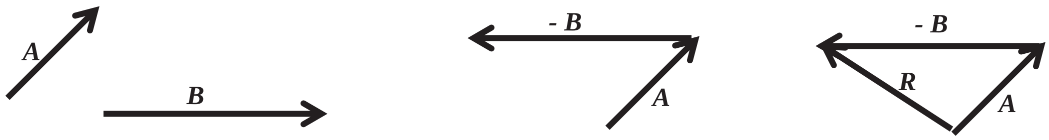


Tip to Tail

A + ***B***



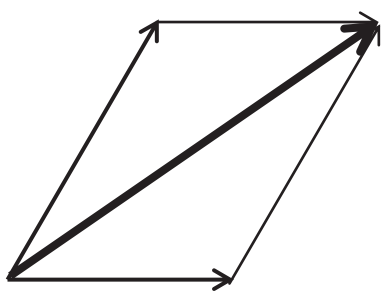
A – ***B***



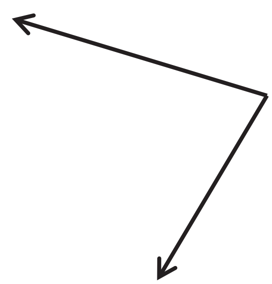
It is readily apparent that both methods arrive at the exact same solution since either method is essentially a parallelogram. It is useful to understand both systems. In some problems one method is advantageous, while in other problems the alternative method is superior.

Draw the resultant vector using the *parallelogram method* of vector addition. (make sure you draw carefully).

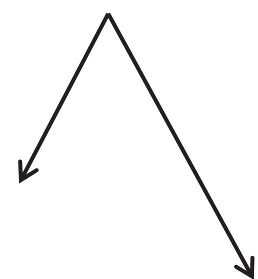
Example



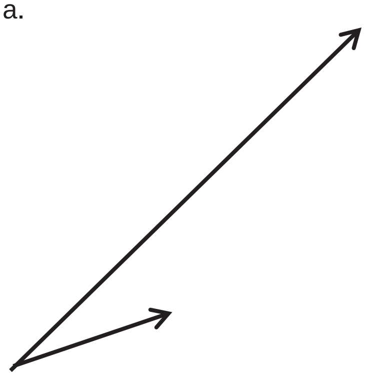
b.



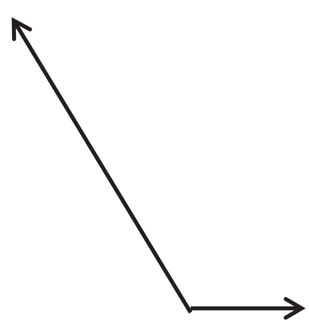
d.



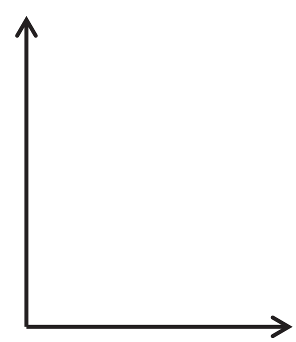
a.



c.



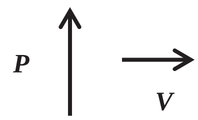
e.



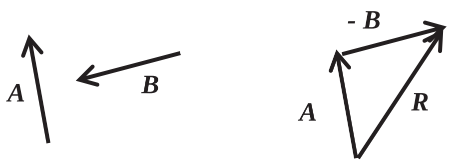
Draw the resultant vector using the tip to tail method of vector addition. Label the resultant as vector ***R***

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

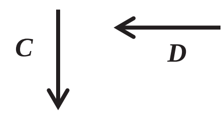
h. ***P*** + ***V***



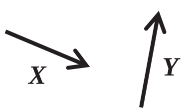
Example 2: ***A*** – ***B***



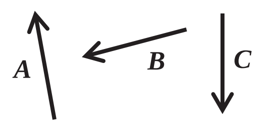
i. ***C*** – ***D***



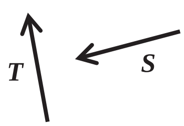
f. ***X*** + ***Y***



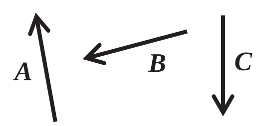
j. ***A*** + ***B*** + ***C***



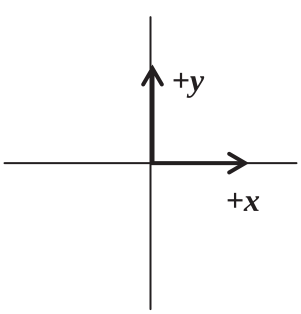
g. ***T*** – ***S***

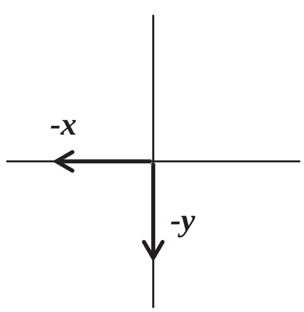


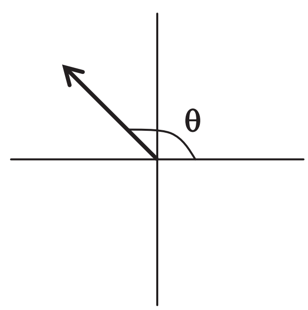
k. ***A*** – ***B*** – ***C***



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, which will be used sparingly in this course).





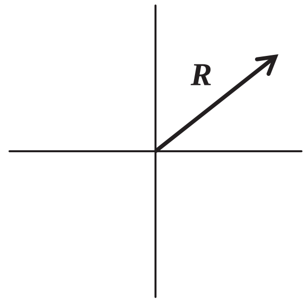


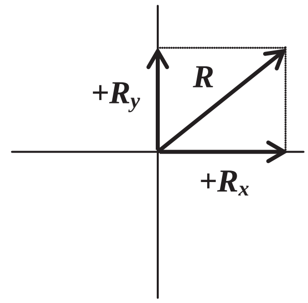
What about vectors that don’t fall on the axis? You must specify their direction using degrees measured from East.

Component Vectors

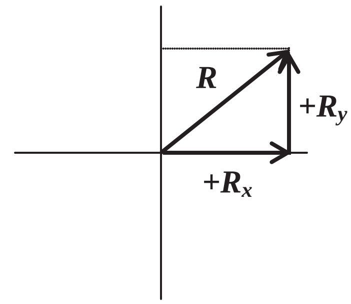
A resultant vector is a vector resulting from the sum of two or more other vectors. Mathematically the resultant has the same magnitude and direction as the total of the vectors that compose the resultant. Could a vector be described by two or more other vectors? Would they have the same total result?

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.





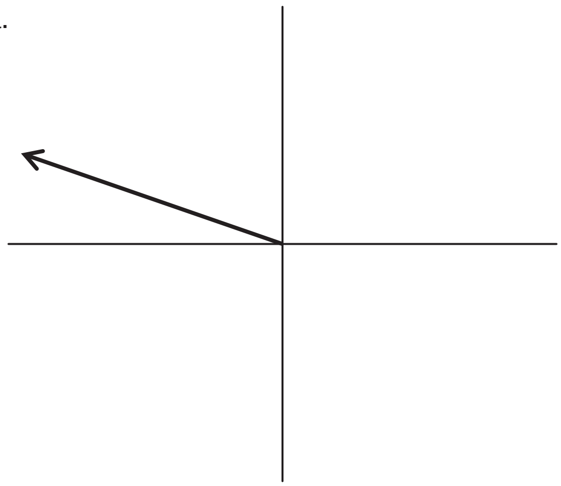
or



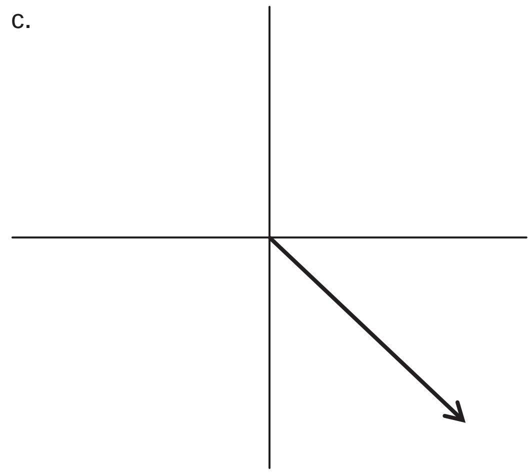
Any vector can be described by an ***x*** axis vector and a ***y*** axis vector which summed together mean the exact same thing. The advantage is you can then use plus and minus signs for direction instead of the angle.

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

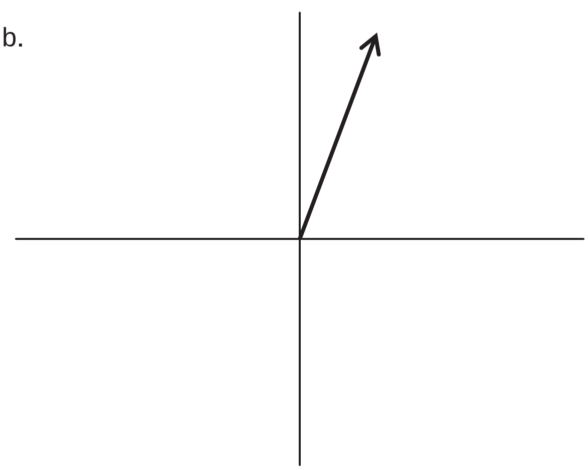
a.



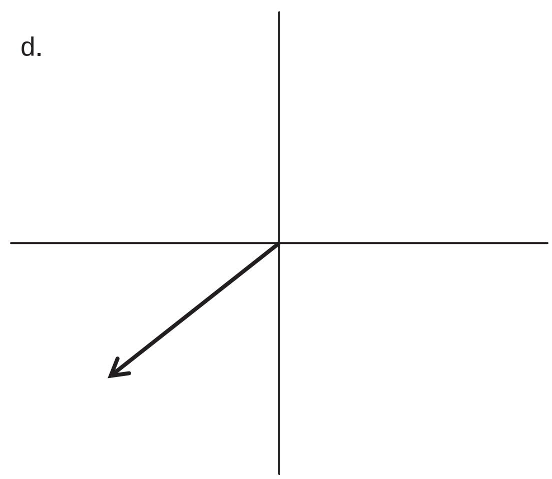
c.



b.



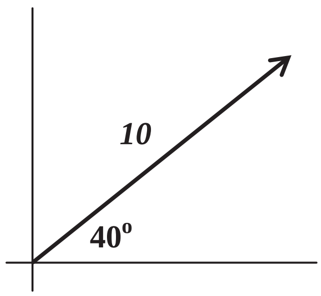
d.

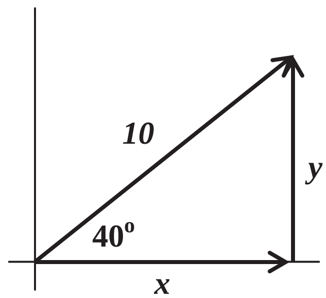


Obviously the quadrant that a vector is in determines the sign of the ***x*** and ***y*** component vectors.

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. Again, any math done with the component vectors will be as valid as with the original vector. The advantage is that math on the ***x*** and/or ***y*** axis is greatly simplified since direction can be specified with plus and minus signs instead of degrees. But, how do you mathematically find the length of the component vectors? Use trigonometry.





$$\cos\theta = \frac{adj}{hyp} \qquad \sin\theta = \frac{opp}{hyp}$$

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

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

$$x = 10\cos 40^o \qquad y = 10\sin 40^o$$

$$x = 7.66 \qquad y = 6.43$$

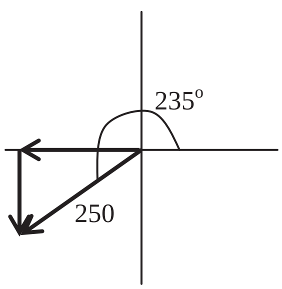
Solve the following problems. You will be converting from a polar vector, where direction is specified in ***degrees measured counterclockwise from east***, to component vectors along the ***x*** and ***y*** axis. Remember the plus and minus signs on your answers. They correspond with the quadrant the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



$$x = hyp\cos\theta$$

$$x = 250\cos 235^o$$

$$x = -143$$

$$y = hyp\sin\theta$$

$$y = 250\sin 235^o$$

$$y = -205$$

a. 89 at 150^o

b. 6.50 at 345^o

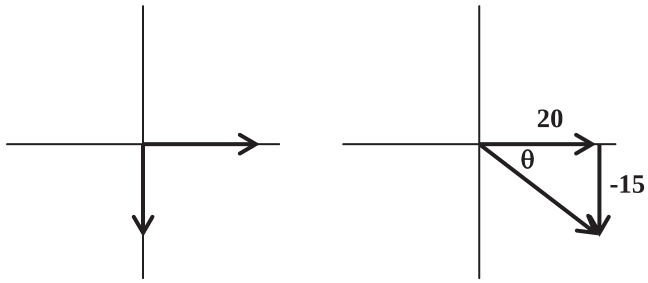
c. 0.00556 at 60^o

d. $7.5\text{x}10^4$ at 180^o

e. 12 at 265^o

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

Example: $\boldsymbol{x} = 20$, $\boldsymbol{y} = -15$



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

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

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

$$R = 25$$

f. $\boldsymbol{x} = 600$, $\boldsymbol{y} = 400$

i. $\boldsymbol{x} = 0.0065$, $\boldsymbol{y} = -0.0090$

g. $\boldsymbol{x} = -0.75$, $\boldsymbol{y} = -1.25$

j. $\boldsymbol{x} = 20{,}000$, $\boldsymbol{y} = 14{,}000$

h. $\boldsymbol{x} = -32$, $\boldsymbol{y} = 16$

f. $\boldsymbol{x} = 325$, $\boldsymbol{y} = 998$

How are vectors used in Physics? They are used everywhere!

SECTION SEVEN: Introduction to Motion

Now that you have a mathematical introduction to physics it is time to start applying some of that math to physical concepts and some actual equations.

DISTANCE VS DISPLACEMENT

Distance is a scalar.

Displacement is a vector for distance traveled in a straight line.

Displacement is measured from the origin. It is a value of how far away from the origin you are at the end of the problem. The direction of a displacement is the shortest straight line from the location at the beginning of the problem to the location at the end of the problem.

How do distance and displacement differ?

You walk 20 meters down the ***+ x*** axis and turn around and walk 10 meters down the ***– x*** axis.

~The distance traveled does not depend on direction since it is a scalar, so you walked

20 + 10 = 30 meter.

~Displacement only cares about you distance from the origin at the end of the problem.

. +20 – 10 = 10 meter.

Formula for Displacement: $\Delta x = x_{final} - x_{initial}$

Questions:

a. A car travels 35 *km* west and 75 km east. What distance did it travel?

b. A car travels 35 *km* west and 75 *km* east. What is its displacement?

c. A car travels 35 *km* west, 90 *km* north. What distance did it travel?

d. A car travels 35 *km* west, 90 *km* north. What is its displacement?

SPEED VS VELOCITY

Speed is a scalar. It only has magnitude (numerical value).

s = 10 *m/s* means that an object is going 10 meters every second. But, we do not know where it is going.

Velocity is a vector. It is has of both magnitude and direction. Speed is the numerical part of velocity.

v = 10 *m/s* north, or ***v*** = 10 *m/s* in the ***+x*** direction, etc.

RATE

Speed and velocity are rates. A rate is a way to quantify anything that takes place during a time interval. Rates are easily recognized. They always have time in the denominator.

10 *m/s* 10 meters / second

Often rates are graphed to see the relationships between variables better.

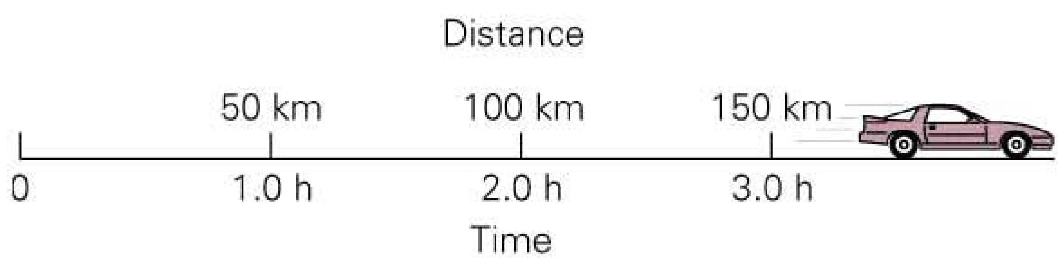
AVERAGE VELOCITY

Average velocity: If you take a trip you might go slow part of the way and fast at other times. If you take the total displacement divided by the time traveled you get the average velocity over the whole trip. If you looked at your speedometer from time to time you would have recorded a variety of instantaneous speeds. You could go 0 *m/s* in a gas station, or at a light. You could go 30 *m/s* on the highway, and only go 10 *m/s* on surface streets.

Formula:
$$\overline{v} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

v stands for velocity ***x*** stands for position ***t*** stands for time

***Question*:** A car moves from position x = 0 km to x = 150 km in 3 hrs, what is the average velocity of the car?



Graphing Average Velocity: We can now take the data from the problem above and graph it to get a better picture of the motion. The slope then is equal to rise/run or displacement/time (hey that's average velocity!)