AP Physics 1 Summer Assignments

Dear AP Physics 1 Student, kudos to you for taking on the challenge of AP Physics! Attached you will find some physics-related math to work through before the first day of school. The problems require you to apply math concepts that were covered in algebra and trigonometry. Bring your completed sheets on the first day of school.

Please familiarize yourself with the following websites.
https://phet.colorado.edu/en/simulations/category/physics We will use this website extensively for physics simulations.
These websites are good resources for physics concepts:

- http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html http://www.thephysicsaviary.com/APReview.html
- http://www.physicsclassroom.com/
- http://www.learnapphysics.com/apphysics1and2/index.html

https://openstax.org/subjects/science This website provides free online textbooks with links to online simulations.

Finally, you will need a *graph paper* composition notebook on the first day of class. This serves as your Lab Notebook.

I look forward to learning and teaching with you in the fall! Find time to relax and recharge over the summer. I will be checking my district email, so feel free to contact me with any questions and concerns. My email address is Ilona.Sunday@richlandone.org.

Physics Study Sheet for Math

Algebra Skills

1. Solve an equation for any variable. Solve the following for *x*.

a) $v + w = x^2yz$

b) $\frac{2}{x} = \frac{1}{3} + \frac{1}{2}$

c) $\frac{a}{b} = \frac{y}{x}$

d) $\frac{2}{x} = \frac{1}{3} + \frac{y}{2}$

2. Be able to reduce fractions containing powers of ten.

a) $\frac{10^2}{10^{-3}} \cdot 10^4$

b) $\frac{10^3}{10^6}$

3. Be able to take a multiplicative expression to a power.

a) $\left(2 \cdot x^3\right)^2$

b) $\left(\frac{x^2}{y^3}\right)^2$

Science Skills

4. Convert a number into scientific notation in standard form and vice versa. This includes both large numbers (> 1,000) and small numbers (< 0.01).

a) 12,345

b) 15000000

c) 1/100

d) 2/10,000

5. Memorize the multipliers for the following: nano, micro, milli, centi, kilo, mega, giga.

a.) 2,000 mockingbirds = 2 ____________

b.) 1 x 10^6 phones = ______

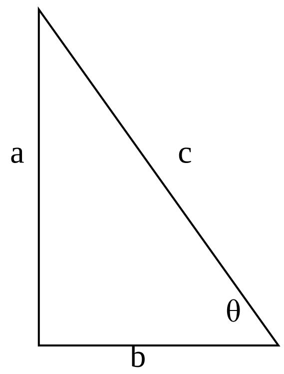
6. Unit conversion: Be able to use the factor-label method. A conversion factor is a multiplier that is equal to one. For example, 1 foot = 12 inches, so ➔ $\frac{1\,foot}{12 inches} = 1$. If we want to convert 113.2 inches to feet, we multiply by the conversion factor: $113.2 inches \cdot \frac{1\,foot}{12 inches} = \frac{113.2\,\cancel{inches}}{1} \cdot \frac{1\,foot}{12\,\cancel{inches}} = \frac{113.2\,feet}{12} = 9.433\,feet$

a) 13.4 inches to feet

b) 4.31 feet to inches

Geometry and Right-Angle Trigonometry

7. Know sin, cos, tan (memorize SOH CAH TOA) and how to apply them to find the side of a right triangle.



8. Know $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$ and how to apply them to find the angle in a right triangle Find the value of θ in the triangle above if a = 57.3 and c = 100.

Know the Pythagorean theorem, be able to use it to find the third side of a right triangle when the other two sides are given.

Do not apply any of the three laws stated above to triangles that are not right triangles.

9. Understanding Ratios. The ratio or fraction $\frac{465}{23}$ signifies the number of times 23 is contained in 465, or the number of successive subtractions of 23 from 465. The result of the division tells us how much of the numerator is associated with one of the denominator.

a) How much will one pound cost if we paid $5.00 for 3 pounds?

b) If the ratio of girls to boys is 5 to 3, how many girls are there if there are 9 boys?

c) If the ratio of length to width is 1.33, what will be the width if the length is 7?

Math Skills Worksheet

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 2.00×10^2, but 2.00×10^8 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. You do not need to know what any of the variables stand for; just do the math and come up with a numerical answer with correct units.

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

2. 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. $v^2 = v_o{}^2 + 2a\left(s - s_o\right)$, $a =$ ____________

b. $K = \dfrac{1}{2}kx^2$, $x =$ ____________

c. $T_p = 2\pi\sqrt{\dfrac{\ell}{g}}$, $g =$ ____________

d. $F_g = G\dfrac{m_1 m_2}{r^2}$, $r =$ ____________

e. $mgh = \dfrac{1}{2}mv^2$, $v =$ ____________

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

g. $\boldsymbol{B = \dfrac{\mu_o}{2\pi}\dfrac{I}{r}}$, $\boldsymbol{r} =$ ____________

h. $x_m = \dfrac{m\lambda L}{d}$, $d =$ ____________

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

j. $\sin\theta_c = \dfrac{n_1}{n_2}$, $\theta_c =$ ____________

k. $qV = \dfrac{1}{2}mv^2$, $v =$ ____________

l. $\dfrac{1}{f} = \dfrac{1}{s_o} + \dfrac{1}{s_i}$, $s_i =$ ____________

3. 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.

kilometers (*km*) to meters (*m*)	minutes (*min*) to seconds (*s*)	gram (*g*) to kilogram (*kg*)
centimeters (*cm*) to meters (*m*)	hours (*hr*) to seconds (*s*)	Celsius (^oC) to Kelvin (*K*)
millimeters (*mm*) to meters (*m*)	days (*d*) to seconds (*s*)	atmospheres (*atm*) to Pascals (*Pa*)
nanometers (*nm*) to meters (*m*)	years (*yr*) to seconds (*s*)	liters (*L*) to cubic meters (m^3)
micrometers (μm) to meters (*m*)		

Other conversions will be taught as they become necessary.

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. 8.8×10^{-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

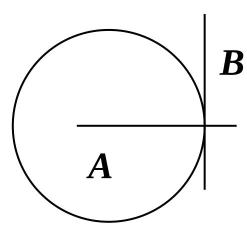
l. 40.0 *cm* = ________________ *m*

m. 6.23×10^{-7} *m* = ________________ *nm*

n. 1.5×10^{11} *m* = ________________ *km*

4. 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?

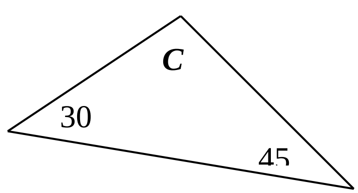
____

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

____

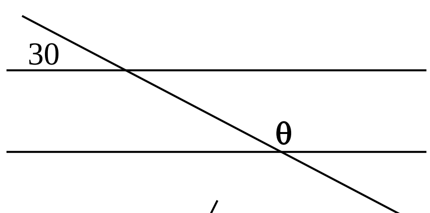
b. What is angle ***C***?

____



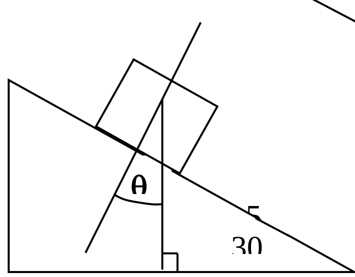
c. What is angle θ ?

____



d. How large is *θ*?

____



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

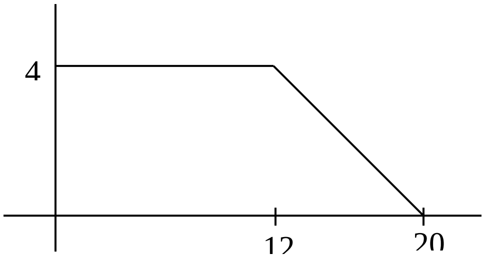
i. What is the circumference in <u>meters</u>?

____

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

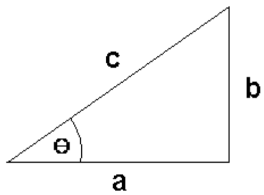
____

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



____

5. Using the generic triangle to the right, solve the following. ***<u>Your calculator must be in degree mode.</u>***



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

____

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

____

i. $\boldsymbol{b}$ = 17.8 *m* and $\theta = 65^o$, solve for $\boldsymbol{a}$ and $\boldsymbol{c}$.

____

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

____

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

____

l. $\boldsymbol{b}$ =65 *cm* and $\boldsymbol{c}$ = 104 *cm*, solve for $\boldsymbol{a}$ and θ.

____

Vectors

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 $\xrightarrow{\vec{A}}$ 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.

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

Vector Addition and subtraction

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

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

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

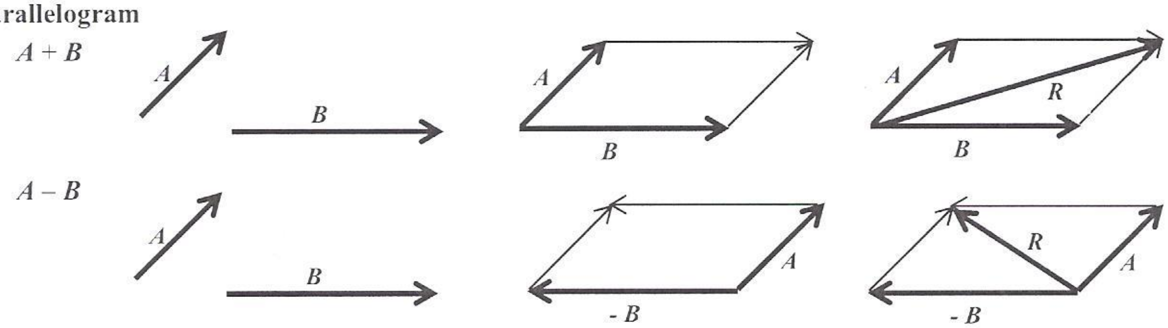
When you need to subtract one vector from another think of the one being subtracted as being a negative vector. Then add them.

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.

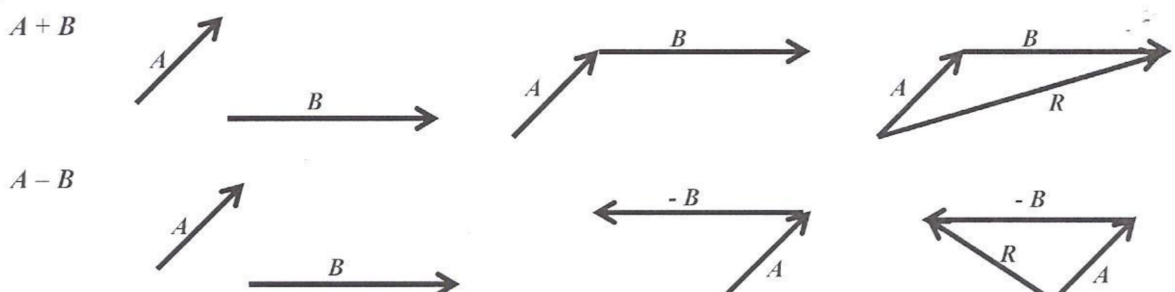
This is very important. In physics a negative number does not always mean a smaller number. Mathematically –2 is smaller than +2, but in physics these numbers have the same magnitude (size), they just point in different directions (180° apart).

There are two methods of adding vectors

Parallelogram



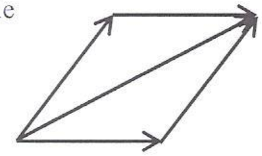
Tip to Tail



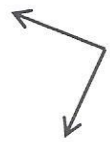
6. Drawing Resultant Vectors

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

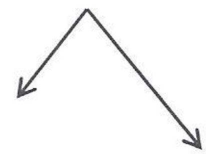
Example



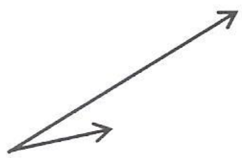
b.



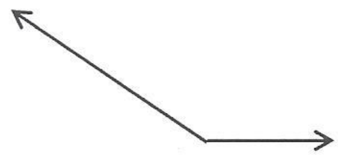
d.



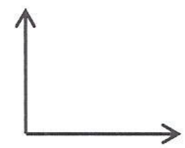
a.



c.

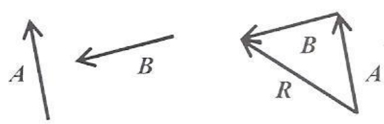


e.

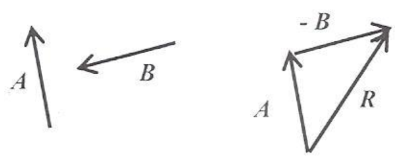


Draw the resultant vector using the tip to tail method of vector addition. Label the resultant as vector ***R***

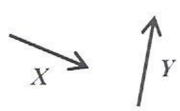
Example 1: ***A*** + ***B***



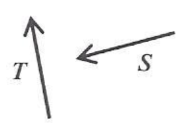
Example 2: ***A*** – ***B***



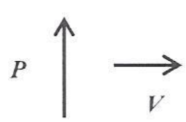
f. $X + Y$



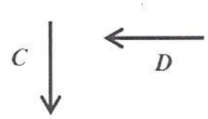
g. $T - S$



h. $P + V$



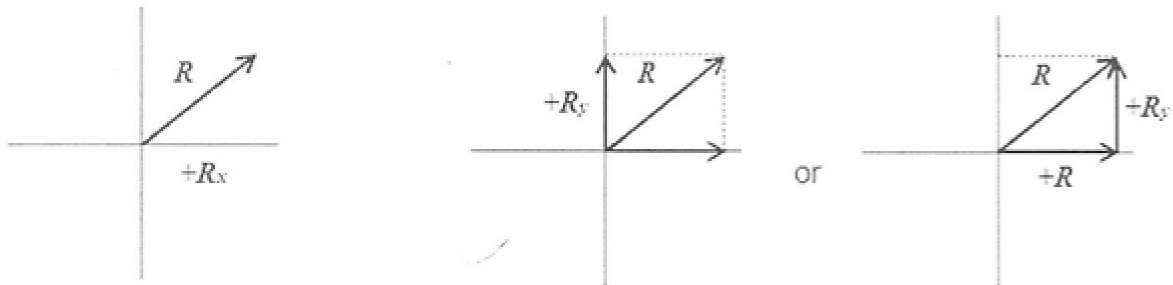
i. $C - D$



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.

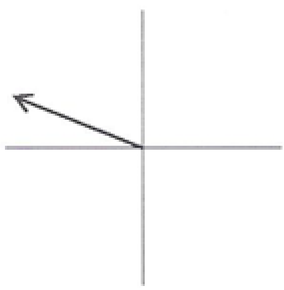


Any vector can be described by an x axis vector and a y axis vector which summed together mean the exact same thing. The advantage is you can then use plus and minus signs for direction instead of the angle.

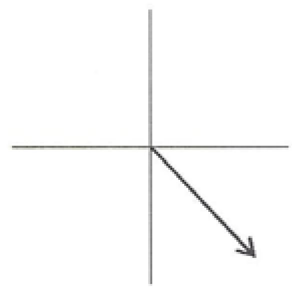
7. Resolving a vector into its components

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

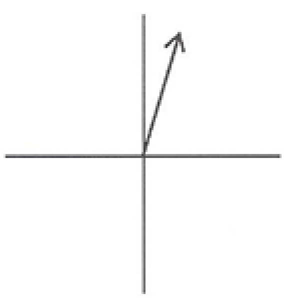
a.



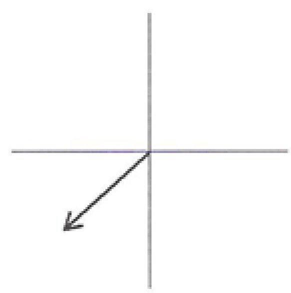
c



b.



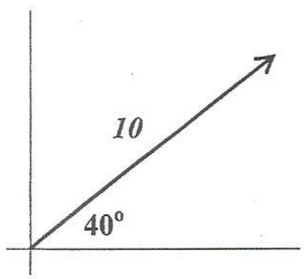
d

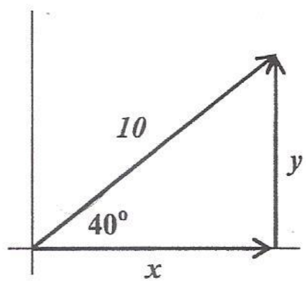


Obviously the quadrant that a vector is in determines the sign of the x and y component vectors

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.





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

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

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

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

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

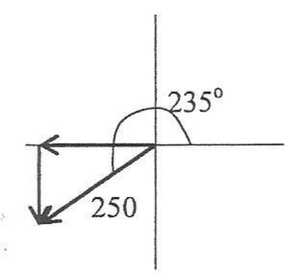
Solve the following problems. You will be converting from a polar vector, where direction is specified in ***degrees measured counterclockwise from east***, to component vectors along the ***x*** and ***y*** axis. Remember the plus and minus signs on you answers. They correspond with the quadrant the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



$$x = hyp\cos\theta$$

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

$$x = -143$$

$$y = hyp\sin\theta$$

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

$$y = -205$$

b. 6.50 at 345°

a. 89 at 150°

c. 0.00556 at 60°

d. $7.5\text{x}10^4$ at 180°

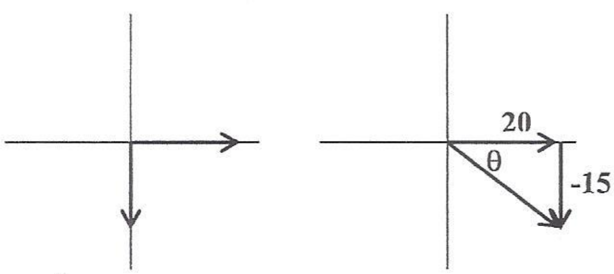
f. 990 at 320°

e. 12 at 265°

g. 8653 at 225°

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: $x = 20$, $y = -15$



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

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

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

$$R = 25$$

$$360^o - 36.9^o = 323.1^o$$

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

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

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

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

e. $x = 20{,}000$, $y = 14{,}000$

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

How are vectors used in Physics?

They are used everywhere!

Speed

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

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

Velocity

Velocity is a vector. It is composed of both magnitude and direction. Speed is a part (numerical value) of velocity.

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

There are three types of speed and three types of velocity

Instantaneous speed / velocity: The speed or velocity at an instant in time. You look down at your speedometer and it says 20 *m/s*. You are traveling at 20 *m/s* at that instant. Your speed or velocity could be changing, but at that moment it is 20 *m/s*.

Average speed / velocity: If you take a trip you might go slow part of the way and fast at other times. If you take the total distance traveled divided by the time traveled you get the average speed 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. But, while there are many instantaneous speeds there is only one average speed for the whole trip.

Constant speed / velocity: If you have cruise control you might travel the whole time at one constant speed. If this is the case then you average speed will equal this constant speed.

A trick question

Will an object traveling at a constant speed of 10 *m/s* also always have constant velocity?

Not always. If the object is turning around a curve or moving in a circle it can have a constant speed of 10 *m/s*, but since it is turning, its direction is changing. And if direction is changing then velocity must change, since velocity is made up of speed and direction.

Constant velocity must have both constant magnitude and constant direction.

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

The very first Physics Equation

Velocity and Speed both share the same equation. Remember speed is the numerical (magnitude) part of velocity. Velocity only differs from speed in that it specifies a direction.

$$v = \frac{x}{t}$$

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

Displacement is a vector for distance traveled in a straight line. It goes with velocity. Distance is a scalar and goes with speed. 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? Supposes 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 your distance from the origin at the end of the problem. +20 – 10 = 10 meter.

Attempt to solve the following problems. Take heed of the following.

Always use the *MKS* system: Units must be in <u>m</u>eters, <u>k</u>ilograms, <u>s</u>econds.

On the all tests, including the AP exam you must:

1. **List the original equation used.**
2. **Show correct substitution.**
3. **Arrive at the correct answer with correct units.**

Distance and displacement are measured in meters (*m*)

Speed and velocity are measured in meters per second (*m/s*)

Time is measured in seconds (*s*)

Example: A car travels 1000 meters in 10 seconds. What is its velocity?

$$v = \frac{x}{t} \qquad v = \frac{1000m}{10s} \qquad v = 100m/s$$

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?

e. A bicyclist pedals at 10 *m/s* in 20 *s*. What distance was traveled?

f. An airplane flies 250.0 *km* at 300 *m/s*. How long does this take?

g. A skydiver falls 3 *km* in 15 *s*. How fast are they going?

h. A car travels 35 *km* west, 90 *km* north in two hours. What is its average speed?

i. A car travels 35 km west, 90 km north in two hours. What is its average velocity?