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Pre–AP® Physics

Summer Assignment

PRE-AP® PHYSICS Summer Assignment

1. The following are example physics problems. Place the answer in correct scientific notation, when appropriate and simplify the units. Work with the units, cancel units when possible, and show the simplified units in the final answer. Make sure your calculator is in degree mode when dealing with angle measurements.

a. $T_p = 2\pi\sqrt{\dfrac{125.4\text{ cm}}{9.81\text{m/s}^2}} =$ ________________

b. $K = \dfrac{1}{2}\ \ 3.6\times10^2\text{ kg}\quad 2.32\times10^5\text{ m/s}\ ^2 =$ ________________

c. $F = \left(8.99\times10^9\ \dfrac{N\times m^2}{C^2}\right)\dfrac{4.2\times10^{-9}C\quad 8.6\times10^{-9}C}{0.22m\ ^2} =$ ________________

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

e. $1.33\ \sin 35.0^o = 1.50\ \sin\theta$ $\qquad \theta =$ ________________

2. For each of the following equations, solve for the variable in **bold** print. Be sure to show each step you take to solve the equation for the **bold** variable.

a. $\lambda = \dfrac{\mathbf{h}}{p}$ ________________

b. $F\ \ \Delta\mathbf{t}\ \ = m\Delta v$ ________________

c. $U = \dfrac{G\mathbf{m}_1 m_2}{r}$ ________________

d. $v^2 = v_0{}^2 + 2\mathbf{a}\Delta x$ ________________

e. $n_1 \sin\theta_1 = n_2 \sin\boldsymbol{\theta}_2$ ________________

f. $\dfrac{1}{s_i} + \dfrac{1}{s_o} = \dfrac{1}{\mathbf{f}}$ ________________

3. Physics uses the ***SI*** system (System Internationale). ***KMS*** stands for kilogram, meter, and second. These are the fundamental units of choice in physics. The equations in physics depend on unit agreement.

Quantity measured	**Unit**	**Symbol**	**Relationship**
Length, width, distance,	millimeter	mm	10 mm = 1 cm
	centimeter	cm	100 cm = 1 m
	meter	m	1×10^9 nm = 1 m
	kilometer	km	1 km = 1000 m
Mass	milligram	mg	1000 mg = 1 g
	gram	g	
	kilogram	kg	1 kg = 1000 g
Time	second	s	
Electric current	ampere	A	

a. 3198 *g* = ________________ *kg*

b. 1.3 *km* = ________________ *m*

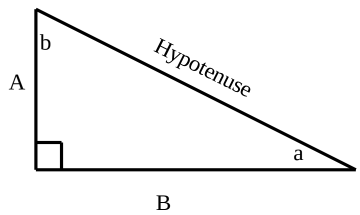
c. 623.7 *nm* = ________________ *m*

d. 1.74 *m* = ________________ *cm*

e. 6.8×10^{-8} *m* = ________________ *mm*

f. 1.2 *A* = ________________ *mA*

4. Examine the right triangles pictured below. Remember a right triangle has a 90° angle and that the sum of all of the angles in any triangle is equal to 180°. The two short sides of this right triangle have been labeled A and B. The longest side of a right triangle is known as the hypotenuse. The right angle is marked and the other two angles are marked with ‘a’ and ‘b’. Notice that the right angle is opposite to the hypotenuse and that angle ‘a’ is opposite to side A and angle ‘b’ is opposite to side B. Also, side B is adjacent (next to) side A. We use the Pythagorean Theorem to calculate the length of any side of a right triangle when the length of the other two sides is known. We use trigonometric relationships to calculate the length of any side of a right triangle when the length of one side and one angle is known.



Pythagorean’s Theorem:

$$\text{Hypotenuse}^2 = A^2 + B^2$$

Trigonometric Relationhips:

$$\frac{O}{H} = \frac{\text{opposite}}{\text{hypotenuse}} = \sin$$

$$\frac{A}{H} = \frac{\text{adjacent}}{\text{hypotenuse}} = \cos$$

$$\frac{O}{A} = \frac{\text{opposite}}{\text{adjacent}} = \tan$$

These relationships are easy to remember if you learn this silly phrase, “Oscar had a heap of apples”. The first letter of each word in the phrase helps you remember the sin, cos, tan relationships in that order. This is the same order as the buttons appear on a scientific calculator so that also simplifies the memory task!

Using the right triangle above, solve for the following. ***Your calculator must be in degree mode.***

a. **a** = 55° and ***hypotenuse*** = 22 *m*, solve for ***A*** and ***B***. ________________

b. **a** = 45° and ***A*** = 15 *m/s*, solve for ***B*** and ***hypotenuse***. ________________

c. ***B*** = 18.7 *m* and **a** = 65°, solve for ***A*** and ***hypotenuse***. ________________

d. ***A*** = 9 *m* and ***B*** = 9 *m*, solve for **a** and ***hypotenuse***. ________________

Vectors

Most of the measurements you have encountered thus far in your science courses are scalar quantities. Scalar quantities communicate only the magnitude or size of a measurement. For instance, a speed of 35m/s has a greater magnitude than a speed of 15m/s. A temperature of 48°C has a smaller magnitude than a temperature of 88°C. Vectors communicate even more information about a measurement. Vectors communicate both magnitude and direction and are drawn so that the length of the vector is proportional to its magnitude. Velocity, displacement, force and momentum are vectors. Speed, mass, time and temperature are scalar quantities.

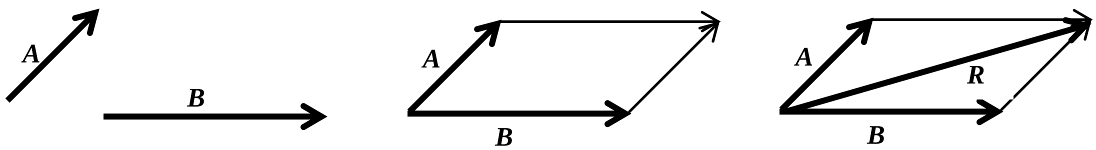
Vector Addition

One method for adding vectors involves manipulating their graphical representations on paper. To do so, you need a ruler to measure and draw the vectors to the correct length, and a protractor to measure the angle that establishes the direction. The length of the arrow should be proportional to the magnitude of the quantity being represented, so you must decide on a scale for your drawing.

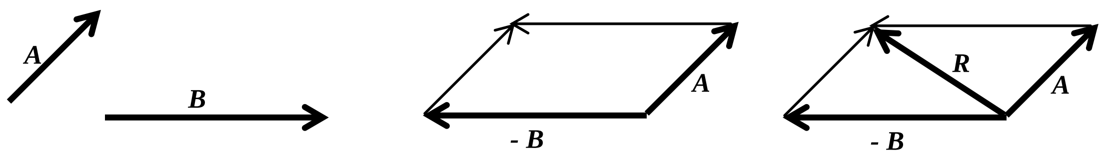
There are two methods of adding vectors

Parallelogram

A* + *B

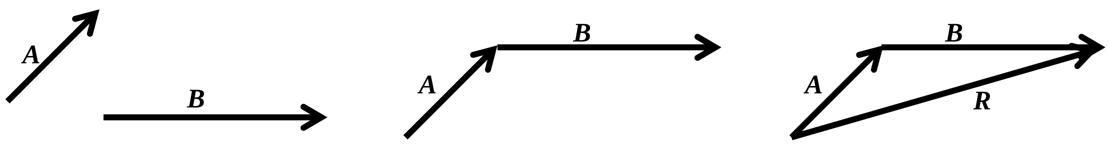


A* – *B

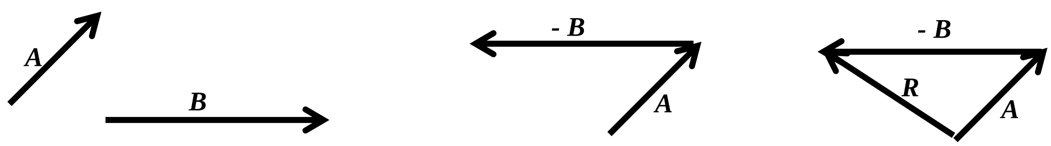


Head to Tail

A* + *B



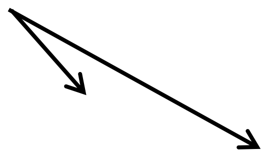
A* – *B



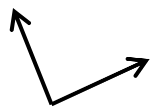
Both methods arrive at the exact same solution since either method is essentially a parallelogram. It is useful to understand both systems. In some problems one method is advantageous, while in other problems the alternative method is more helpful.

5. Draw the resultant vectors using both the parallelogram method and the Head-to-Tail method of vector addition.

a.

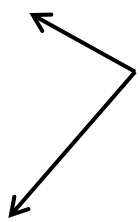


b.

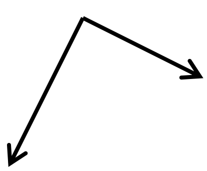


c.

d.



e.



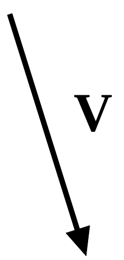
Component Vectors

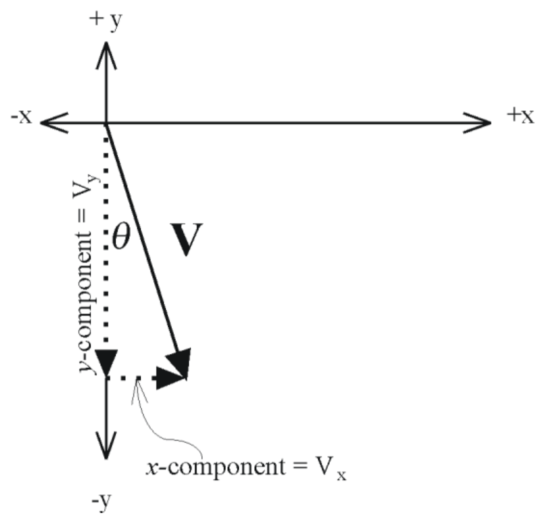
Any vector can be resolved into its components. If a vector lies on either the x-axis or y-axis, it only has one component and the other component is zero. If a vector does not lie on either the x or y-axis, then it has both an x-component and a y-component. Consider the vector, V, pictured below. The easiest way to resolve this vector is to place an x and y-coordinate system at the tail of the vector. Notice that the x-component is positive and that the y-component is negative. Make sure and assign those signs to component vectors, V_x and V_y. The magnitude of the x and y-components is found using the following relationships:

$V_x = V \cos \theta$

$V_y = V \sin \theta$

When redrawn it looks like this:





Construct a chart similar to the following:

Vector name:	x-component $V_x = V \cos \theta$	y-component $V_y = V \sin \theta$
V_1		
V_2		
V_R	$V_{Rx} =$	$V_{Ry} =$

To obtain the magnitude of the resultant vector, V_R:

1. Read the problem and draw a diagram using an appropriate coordinate system.

2. Construct a chart similar to the one above. If more than two vectors are being added, simply add additional rows to the chart.

3. Determine the sign of each component from your diagram and place it in the chart before calculating any values.

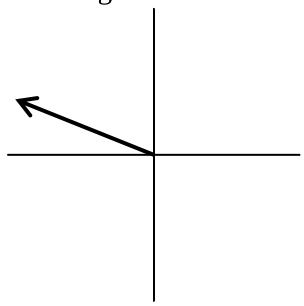
4. Use a scientific calculator to determine the magnitude of each vector's x-component and y-component.

5. Add all of the x-components from the x column to determine V_{Rx} and do the same for the y column to determine V_{Ry}. Pay close attention to the signs of each component for each vector.

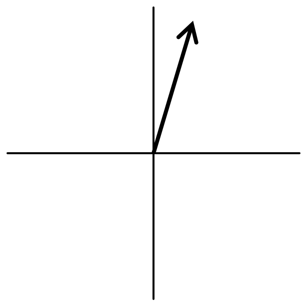
6. Use Pythagorean's theorem to calculate the magnitude of V_R. Find the direction by using $\tan \theta_R = \frac{V_{Ry}}{V_{Rx}}$.

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

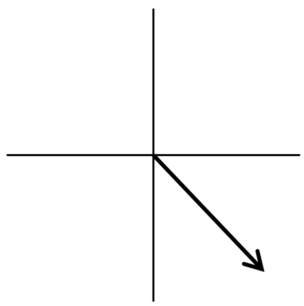
a.



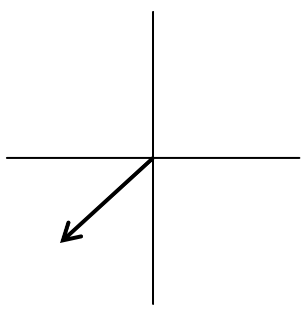
b.



c.

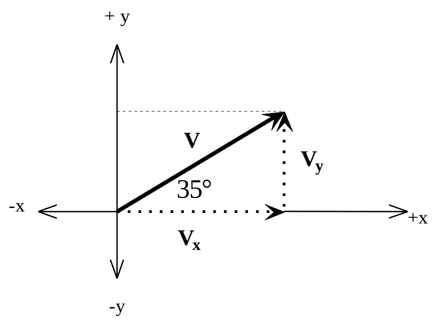


d.



8. **Example 1: Determining components**
A biker travels 23.0 km on a straight road that is 35° north of east. What are the east and north components of the biker's displacement?

Solution:
First draw a diagram. Next, resolve the vector into its *x* and *y*-components using the trigonometric relationships.



$V=23km$ and $\theta=35°$

$V_x = V \cos 35° = 23km \cos 35° = +18.8km$ East

$V_y = V \sin 35° = 23km \cos 35° = +13.2km$ North

Check: $\sqrt{19^2+13^2} = 23km$ as expected

For each of the following questions, include a vector diagram and show all work as you solve each problem using your own paper. . ***<u>Your calculator must be in degree mode.</u>***

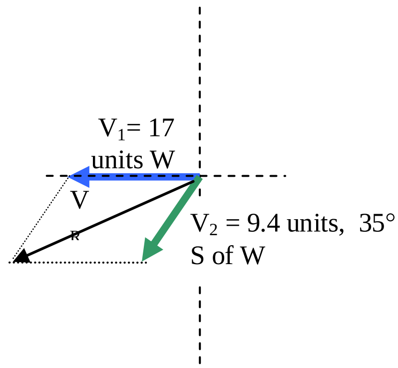
1. A hiker walks 18.5 km at an angle 35° south of east. Find the east and south components of this walk.

2. An airplane flies at 65m/s with a heading of 137°. What are the east and north components of the plane's velocity?

3. A golf ball, hit from the tee, travels 295 m in a direction 28° south of the east axis. What are the east and south components of its displacement?

Example 2: Vector Addition

A vector with a magnitude of 17 units is directed westward. A second vector acts at the same point with a magnitude of 9.4 units and an angle of 35° south of west. Find the resultant.



Vector name:	*x*-component $V_x = V \cos 2$	*y*-component $V_y = V \sin 2$
V_1: lies on the x-axis so that IS its *x*-component. It has NO *y*-component	-17	0
V_2: lies on NEITHER axis, so it has both components	-9.4(cos 35°) V_x = -7.7	-9.4 (sin 35°) V_y = -5.4
V_R	V_{Rx} = -24.7 units	V_{Ry} = -5.4 units

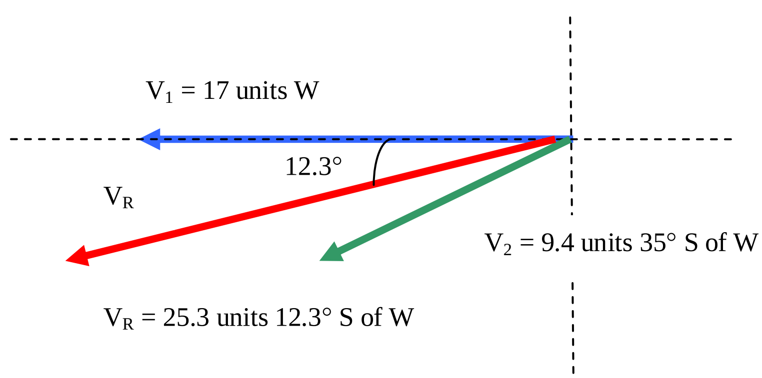
SOLVE for the resultant vector's magnitude and direction now that you know its components:

The magnitude of ***V_R*** *=* $\sqrt{24.7^2 + 5.4^2} = 25.3$ *units [If you use the negative signs in Pythagorean's theorem, you get an error message.] Notice that indeed BOTH the x and y-components of the resultant vector are negative which we correctly predicted from our original drawing.*

To obtain the direction of ***V_R*** *use the relationship,* $\tan\theta = \dfrac{y-component}{x-component} = \dfrac{-5.4}{-24.7}$ *= 0.2186;*

The resultant has a magnitude of 25.3 units and its direction is 12.3° S of W [both negative!]

WE UPDATE OUR DRAWING. SINCE BOTH THE *X* & *Y*-COMPONENTS WERE NEGATIVE, THE RESULTANT IS 12.3° SOUTH OF WEST.



For each of the following questions, include a vector diagram and a problem-solving chart as you solve each problem using your own paper.

4. Determine the magnitude and direction of the resultant velocity of 75.0 m/s, 25.0° east of north, and 100.0 m/s, 25.0 ° east of south.

5. An airplane flies due south at 195 km/h with respect to the air. There is a wind blowing at 75 km/h to the northeast relative to the ground. What are the plane's speed and direction with respect to the ground?

6. A person can row a boat at the rate of 8.0 km/h in still water. The person heads the boat directly across a stream that flows downstream at the rate of 6.0 km/h. Find the resultant velocity.

7. An airplane must fly at a ground speed of 425 km/h in a direction of 10.0° east of south to be on course and on schedule. If the wind velocity is 25.0 km/h 40.0° east of north, in what direction and at what speed relative to the air must the pilot fly? [Notice this problem doesn't simply ask for the resultant, you'll have to use the resultant to correct the pilot's course!]