AP Physics 1 – Summer Assignment
Oak Park High School
Chris Goll, Instructor

Things To Do List:

1) Preferably today, but no later than June 30th, email me at chris.goll@nkcschools.org and introduce yourself. This will provide me with a tentative list of students in the class in case I need to send updated information. Please include the following information with your email:
    - first name, last name, last math class taken and grade earned.
    - What do you hope to get out of AP Physics 1 besides a good grade?
2) Attached to this packet are practice problems in math, which are due the first day of AP Physics 1. It is expected that you understand and know how to work the problems in this packet. If you have forgotten how to do some things, you need to get yourself caught up (and you have all summer to do that). If you don't know how to do all of the problems, you are already behind. Don't fall behind. Email me if you have questions (chris.goll@nkcschools.org). Always use your school email address.
3) In addition to your textbook, here are some websites that you might find helpful. I highly recommend you make time to visit these sites and familiarize yourself with them. You may find them very helpful in your review.
    - www.**physicsclassroom**.com/
    - http://www.archive.org/details/pa_physics_b
    - http://ocw.mit.edu/OcwWeb/hs/physics/physics/index.htm
    - http://www.animatuons.physics.unsw.edu.au/mechanics/index.html
    - http://brightstorm.com

    You may also want to check out the following sites for physics content:
    - Wake Forest Lecture Series
    - APPhysicsLectures.com

- College Board
- Khan Academy
- LearnAPPhysics

Enjoy and Review!

Have a great summer ☺

Chris Goll
Physics Teacher
Oak Park High School

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    - http://ocw.mit.edu/OcwWeb/hs/physics/physics/index.htm
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Expect to be challenged! That is what it all comes down to in AP Physics 1. This is a college level course where you will be using your knowledge and understanding of everything you have learned in all of your course work to solve problems, analyze situations, arrange materials, compare data, design labs, and build advanced conceptual models. That is physics!

Success, Effectiveness, Performance:
You cannot expect to acquire the understanding you need to do well on an AP Exam by merely attending class and listening to the teacher. You have to become INVOLVED. YOU have to participate. If you get stuck see other students or me. Ask for help. Your classmates will become your new best friends and allies.

You must study regularly. Students who study regularly have a good foundation to build on for new topics. This will pay off! If you are unorganized or inconsistent, things may start to fall apart, and no one wants that to happen. Show some self-discipline and do what I ask of you regularly. Especially the homework!
Homework = Practice = Success.

Draw a sketch when you are working problems. Solve your problems neatly and SHOW ALL STEPS or you will not get credit. You will be busy, and that is ok. An AP course does that to you. You signed up for it. Before and after school help is always available.

Textbook available from OP Library: College Physics, Knight et. al, 2nd edition.

Topics of Study: constant and accelerated motion, forces and Newton's Laws, 2-D motion, rotational mechanics, momentum and impulse, energy and work, simple harmonic motion, waves and wave interactions, simple circuits.

Summer To Do Checklist:

1) email instructor at chris.goll@nkcschools.org by June 30th.
2) Math Practice (due first day of school)
3) Evaluate online resources listed in packet

AP Physics B Summer Assignment

Read all information carefully and complete all problems. You must show your work for the problems to receive credit. Work may be shown on a separate sheet of paper if necessary.

Greek Letters

In Physics, we use variables to denote a variety of unknowns and concepts. Many of these variables are letters of the Greek alphabet. If you are not familiar with these letters, you should become so. While there is no practice work for this section and while you do not have to outright memorize these letters at this point, you need to have this exposure so that when class starts and you see this on the board: μ you don't call it, "that funny-looking m-thing".

These variables have specific names and I will be using these names. You need to do this as well.

Greek Letter	**Name**	**Commonly used for**
α	Alpha (lowercase)	Angular acceleration, radiation particle
β	Beta (lowercase)	Radiation particle
Δ	Delta (uppercase)	Showing a change in a quantity
ε	Epsilon (lowercase)	Permittivity
ϕ	Phi (lowercase)	Magnetic Flux, work function
γ	Gamma (lowercase)	Radioactivity, relativity
λ	Lambda (lowercase)	Wavelength
μ	Mu (lowercase)	coefficient of friction
π	Pi (lowercase)	Mathematical constant
θ	Theta (lowercase)	Angle name
ρ	Rho (lowercase)	Density, resistivity
Σ	Sigma (uppercase)	Showing the sum of numbers
τ	Tau (lowercase)	Torque
ω	Omega (lowercase)	Angular velocity
ξ	Xi (uppercase)	Electromotive force; induced voltage

The Metric System

Everything in physics is measured in the metric system. The only time that you will see English units is when you convert them to metric units. The metric system is also called SI (from the French, "Système International"). In the SI system fundamental quantities are measured in meters, kilograms, and seconds.

Here are the metric prefixes that we will use throughout the year:

Name of prefix	Numerical value	Abbreviation
pico-	10^{-12}	p
nano-	10^{-9}	n
micro-	10^{-6}	μ
milli-	10^{-3}	m
centi-	10^{-2}	c
kilo-	10^{3}	k
mega-	10^{6}	M
Giga	10^{9}	G

Name: ______________________________

AP Physics B - Scientific Notation

Scientific Notation: When a number is in scientific notation, the form is of a number multiplied by 10 raised to some power or:

$A \times 10^B$ (where A can be a decimal and B is an integer)

Fill in the chart to practice turning some easy numbers into scientific notation.

Factor of 10 (Expanded Notation)	What it means	Factor of 10 (Scientific Notation)
1,000,000	10 x 10 x 10 x 10 x 10 x 10	1×10^6
100,000		
10,000		
1,000		
100		
10		
1		
0.1		
0.01		
0.001	$\frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} = \frac{1}{1,000}$	1×10^{-3}

Expanded Notation: When a number is in expanded notation, it is not multiplied by a factor of 10 anymore. OR, you can consider it to be multiplied by 10^0, which will not change its value because it is mathematically equivalent to the number 1. (Ex.: $240 = 240 \times 10^0$ $3.14 = 3.14 \times 10^0$ $0.042 = 0.042 \times 10^0$)

Since it is often advantageous to put numbers in scientific notation, here are the rules:

Rules:

I) Only one nonzero digit (1-9) before the decimal point.

II) When you move the decimal point to the Left, the exponent gets Larger.

III) When you move the decimal point to the Right, the exponent gets Reduced.

So, when you put a number in scientific notation, slap a 10^0 on the end, and then move the decimal point until it conforms to Rule 1. When you expand a number out of scientific notation, move the decimal until the exponent becomes zero, and then get rid of the 10^0. (Simply don't write it.)

(Answers are given on the back page.) (Are you boxing in your answers, like you should?)

Put the following in scientific notation:

1) 1,230,000

2) 0.0025

3) 6

Expand the following:

4) 1.54×10^4

5) 2.71828×10^0

6) 5.67×10^{-21}

IV) When adding or subtracting numbers in scientific notation, the factor of ten (exponent) must be the same before you add or subtract. This may mean that you, temporarily, need to change a number so it is not in scientific notation anymore.

7) As of 6/4/12, according to the U.S. Census Bureau web site, there are approximately 313,675,000 people in the United States and the world population is approximately 7,017,789,000 people.

a) Change each number into scientific notation. (If you need more room for any of these problems, feel free to use a separate sheet.)

b) If the U.S. population were to suddenly hop in spaceships and leave for Mars, what would the new world population be? Put your answer in scientific notation.

8) The radius of the Earth is 6,378,000 **meters**. Cheryl Stearns, an ex-pilot and 21-time U.S. women's skydiving champion trained to dive from 130,000 feet above the Earth's surface (that's about 39,600 **meters**).

a) Change each number (in meters) into scientific notation.

b) At the top of the skydive, how far would Ms. Stearns be from the center of the Earth? Put your answer in scientific notation.

V) When multiplying numbers in scientific notation, multiply the numbers in front and add the exponents. (think: $100 \times 1000 = (1 \times 10^2) \times (1 \times 10^3) = 1 \times 10^5 = 100{,}000$) **When dividing, divide the numbers and subtract the exponents.** (think: $100 / 1000 = (1 \times 10^2) / (1 \times 10^3) = 1 \times 10^{-1} = 0.1$) **(If an exponent is a negative number, keep it as a negative number.) Then, refer back to Rules 1 – 3 to make sure your answer is in scientific notation.**

9) The acceleration of an electron around a hydrogen nucleus is about 90,000,000,000,000,000,000,000 m/s^2. The mass of an electron is about 0.000000000000000000000000000000911 kg. Find the net force on this electron.

10) The Moon (mass = 73,500,000,000,000,000,000,000 kg) circles around the Earth once every 27.322 days (2,360,600 seconds). Its distance from the Earth (radius of rotation) is about 384,400,000 meters. Put each number in scientific notation. Find the Moon's tangential speed, which is equal to circumference divided by time. Put your answer in scientific notation.

(There's still more problems on the back of the next page.)

Scientific Calculators and Scientific Notation – A Quick Tour

While it is important to know the fundamentals of scientific notation, it is also important to know the shortcuts and how to use the tools that are available to you - namely, your scientific calculator.

All scientific calculators have a button on them that allows you to enter a number in scientific notation. The buttons are labeled differently on different brands of calculators. The most common labels are: EE or EXP. Find yours. If you can't locate it, ask another student for help. My calculator has the EE label, so that is what I will use in this guide when referring to that button.

When you press the EE button, it takes the place of the words "times 10 to the . . ." in the name of the number you are entering. So, to enter the number 3×10^8 in your calculator (which is said, "three times ten to the eighth"), you would press the following buttons, in this sequence:

3	EE	8

Notice that you never have to hit the digits 1 and 0! You don't have to hit the x button! You don't have to find the exponent button! It's all taken care of with the EE button. Boy, whoever decided to include this button on the scientific calculator should get a medal.

When you look at the display, you might see something that looks like this: 3^8. Your calculator is NOT reading "three to the eighth power." That would be the number 6561 because it would be $3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3$. Most calculators display numbers in scientific notation by putting the exponent up in the corner. This is due to the space restrictions of the screen. Some newer calculators may not do this because they have bigger screens.

Then there's the graphing calculators. They often display numbers in scientific notation like so: 3E8. That also means 3×10^8. Get used to it. You need to be able to recognize how your calculator displays scientific notation. No matter how yours does it, though, here's something to remember:

YOU MAY **NOT** WRITE A NUMBER AS 3E8 OR 3^8 WHEN YOU MEAN $3 \text{ X } 10^8$.

I will not accept 3E8 on your tests or quizzes because that is calculator-speak. I certainly will not accept 3^8 because that is the WRONG NUMBER (remember – it's 6561, as opposed to 300,000,000).

Now, problems become much easier and quicker. Try this:

1) The speed of light is a constant 3.00×10^8 m/s. How far can light travel in 1 year (about 3.15×10^7 s)? Since this is a distance problem, we'll use $d = vt$. To multiply these numbers, enter the following sequence:

3	EE	8	x	3	.	1	5	EE	7	=

Your answer should come out to 9.45×10^{15} m. You can check it if you like, using the rules for scientific notation that you learned on the first sheet.

Hey – your calculator even puts the answer in scientific notation for you (usually)! How nice.

Go back to the previous sheet and try the calculations there using the EE button. Check to make sure you are familiar with it and its uses. For example, to enter numbers with negative exponents just takes a few more keystrokes, in a logical order. Let's take the mass of the electron, which is 9.11×10^{-31} kg:

9	.	1	1	EE	+/-	3	1

It also works if you hit the +/- button after entering the exponent on my calculator. Play around with yours. What DOESN'T work is hitting the +/- button any time before hitting the EE button. Try this and you'll see that you don't get 9.11×10^{-31}; you get -9.11×10^{31}. Make sure that you are careful and that you put the negative sign where you want it.

Do the problems below (answers are in parentheses). If you haven't learned the terms mentioned yet, come back to these after doing the appropriate section of the Physics Classroom web site.

2) Find the weight of a proton (mass = 1.67×10^{-27} kg), using 9.8 m/s^2 for the acceleration due to gravity. Put your answer in scientific notation. (1.64×10^{-26} N)

3) Find the time it takes for an electron to travel a distance of 3.10×10^{-3} m when it starts from rest and experiences an acceleration of 7.68×10^{10} m/s^2. (2.84×10^{-7} s)

4) An ion experiences a net force of 6.00×10^{-14} N. It starts from rest and acquires a speed of 3.40×10^5 m/s in a time of 3.76×10^{-8} seconds. Find its mass. Put your answer in scientific notation. (6.64×10^{-27} kg)

Answers

1) 1.23×10^6 2) 2.5×10^{-3} 3) 6×10^0 4) 15,400 5) 2.71828	6) 0.000000000000000000000567 7) a) U.S.: 3.13675×10^8 world: 7.017789×10^9 b) 6.70411×10^9 people	8) a) $r_{Earth} = 6.378 \times 10^6$ m altitude = 3.96×10^4 m b) 6.4176×10^6 m	9) 8.2×10^{-8} N 10) a) 3.85×10^{28} J

Name: ______________________________

AP Physics B – Significant Figures

Accuracy – describes how close a measured value is to the true value of the quantity measured. Problems with accuracy are due to error, whether there is a problem with the measuring device (equipment error) or with the person making the measurement (human error).

Precision – refers to the degree of exactness with which a measurement is made and stated. Precision describes the limitations of the measuring instrument.

Significant Figures – (or "sig. figs.") those digits in a measurement that are known with certainty plus the first digit that is uncertain. Generally, a measurement, including the appropriate unit, is taken to one-tenth the smallest division of the instrument being used (that is the "estimated" digit). Significant figures help keep track of imprecision.

Rules for counting significant figures:

1. Nonzero digits are significant.
2. Zeros between other nonzero digits are significant.
3. Zeros in front of nonzero digits are not significant.
4. Zeros at the end of a number and also to the right of the decimal are significant.
5. Zeros at the end of a number but to the left of a decimal are significant if they have been measured or are the first estimated digit; otherwise, they are not significant. Generally, they are treated as not significant.
6. Use proper scientific notation when possible – all digits are significant.

Examples:

Value	Number of Sig. Figs.	Rule(s)
1	1	1
1.0	2	4
1.00	3	4
0.1	1	3
0.10	2	3,4
0.100	3	3,4
0.01	1	3

Value	Number of Sig. Figs.	Rule(s)
10	1	5
100	1	5
101	3	2
1010	3	2,5
1010.1	5	2
1010.0	5	2,4
1.0×10^7	2	6

Rules for calculating with significant figures:

Addition/Subtraction – The final answer should have the same number of digits to the right of the decimal as the measurement with the smallest number of digits to the right of the decimal.

Multiplication/Division – The final answer has the same number of significant figures as the measurement having the smallest number of significant figures.

You may assume that numbers not measured (e.g., constants and conversion factors) have an infinite number of significant figures.

Unless otherwise directed, the general "rule of thumb" in this course is that you should carry **three significant figures** in your problems even if the author provides given information with less than three significant figures. After performing the calculations and determining the proper number of sig. figs. for that particular problem, your answer should also be **rounded** correctly.

(continued on the back)

(continued from the front)

Problems: (Answers – don't peek yet! – are at the bottom of the page.)

1) Write in the number of significant figures for each measurement and list which rule(s) tells you why the zeroes (if there are any) are significant or not.

Measurement	Number of Sig. Figs.	Rule
a) 50.3 m		
b) 3.0025 s		
c) 0.892 kg		
d) 0.0008 μs		
e) 57.00 g		
f) 2.0 x 10^2 kg		

Measurement	Number of Sig. Figs.	Rule
g) 1000 m		
h) 20		
i) 300,000,000 m/s		
j) 3 x 10^8 m/s		
k) 8.99 x 10^9 N·m²/C²		
l) 8,990,000,000 N·m²/C²		

2) Your calculator reads 57.08506224. Assuming this is a distance measured in meters, round this value to:

a) 3 sig. figs.: ____________ b) 2 sig. figs.: ____________

c) 4 sig. figs.: ____________ d) 1 sig. fig.: ____________

3) Your calculator reads 0.003737373. Assuming this is time measured in seconds, round this value to:

a) 3 sig. figs.: ____________ b) 2 sig. figs.: ____________

c) 4 sig. figs.: ____________ d) 1 sig. fig.: ____________

4) In a problem, you need to divide 2.2 m by another number. Perform the calculation and round your answer to the correct number of sig. figs. if that second number is:

a) 5 s: ____________ b) 5.15 s: ____________

c) 5.2 s: ____________ d) 5.146 s: ____________

Answers

1) a) 3 **b)** 5 **c)** 3 **d)** 1 **e)** 4 **f)** 2 **g)** 1 **h)** 1 **i)** 1 **j)** 1 **k)** 3 **l)** 3 **2) a)** 57.1 m **b)** 57 m **c)** 57.09 m **d)** 60 m
3) a) 0.00374 s **b)** 0.0037 s **c)** 0.003737 s **d)** 0.004 s **4) a)** 0.4 m/s **b)** 0.43 m/s **c)** 0.42 m/s **d)** 0.43 m/s

Name: ______________________________

Trigonometry Reference

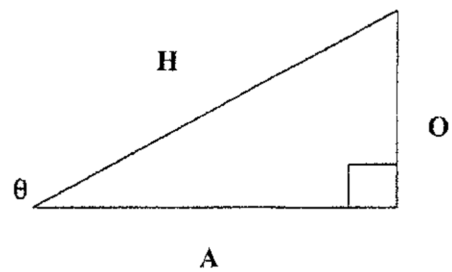
The trigonometric functions (sine, cosine, and tangent) are ratios of sides of a right triangle. The diagram below shows a generic right triangle, with its sides labeled: opposite (O), adjacent (A), and hypotenuse (H). The right angle is designated by the square in the corner. One of the other angles is labeled by the symbol for angle – the Greek letter theta (θ).

Trigonometric Functions

sine: $\sin\theta = \frac{O}{H}$

cosine: $\cos\theta = \frac{A}{H}$

tangent: $\tan\theta = \frac{O}{A}$



opposite (O) – the side of the triangle across from the angle (θ) in question.
adjacent (A) – the side of the triangle next to the angle (θ) in question.
hypotenuse (H) – the side of the triangle across from the right angle; necessarily, the longest side of the triangle.

The easy way to remember the trig. functions is this: **SOHCAHTOA**.

S ine
O opposite
H ypotenuse
C osine
A djacent
H ypotenuse
T angent
O opposite
A djacent

Another helpful equation when dealing with right triangles is the Pythagorean Theorem, which looks like this:

$$a^2 + b^2 = c^2$$

where **a**, **b**, and **c** are the three sides of a right triangle, with c being the hypotenuse. If you want to use the symbols previously defined, it would look like this:

$$O^2 + A^2 = H^2$$

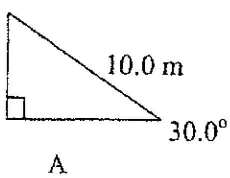
The following problems will give you practice using the trig. functions and using your calculator. Before you start, you need to make sure your calculator is in the correct mode. There are various ways to measure angles; for this class, we will use degrees (°). Make sure your calculator is in degree mode. If you need help doing this, ask Mr. Sadowsky.

Plug the following angles into the trig. functions. Report your answer to 3 decimal places.

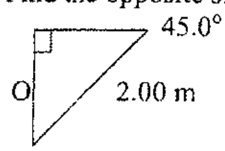
θ	$\sin\theta$	$\cos\theta$	$\tan\theta$
1) 0°			
2) 90°			
3) 30°			
4) 45°			
5) 60°			

For the next group, you will have to pick the correct trig. function to use and then rearrange it to solve for the requested side of the triangle. The angle, θ, stays with its function. In other words, if it is written sinθ, that is NOT "sine times θ." To start you off, if you were to rearrange the cosine function to solve for the adjacent side, it would look like this: $A = H\cos\theta$.

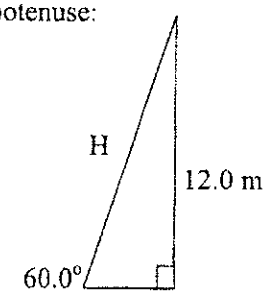
6) Find the adjacent side:



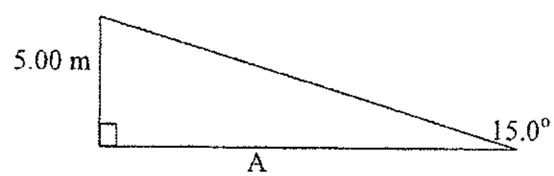
7) Find the opposite side:



8) Find the hypotenuse:

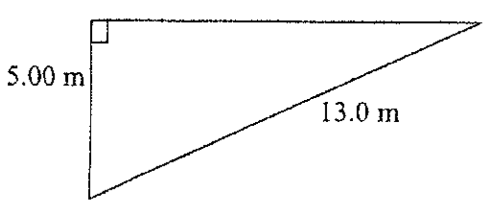


9) Find the adjacent side:

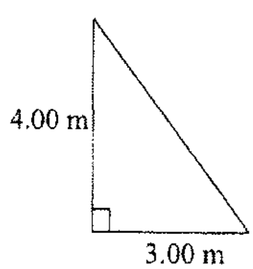


For the next group, find the third side of the triangle:

10)



11)



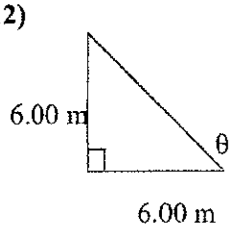
The inverse trig. functions are used to find the angle measure (θ) if you already have two sides of the triangle. They look like this:

Inverse sine	**Inverse cosine**	**Inverse tangent**
$\theta = \sin^{-1} \frac{O}{H}$	$\theta = \cos^{-1} \frac{A}{H}$	$\theta = \tan^{-1} \frac{O}{A}$

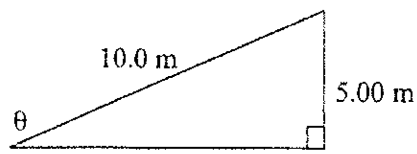
To use these on your calculator, you probably have to press a shift or 2[nd] function key and then the trig. function key. Ask for help if you cannot figure out how to get the inverse trig. functions. For most calculators with a single-line display, you first have to determine the ratio of sides (do the division first) and then evaluate the inverse trig. function. For most multi-line display calculators, you type it in as you see it. Again, remember to have your calculator in degree mode.

For each triangle below, find the angle, θ. You need to decide which trig. function to use, depending on which sides of the triangle you have.

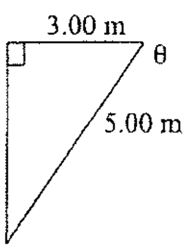
12)



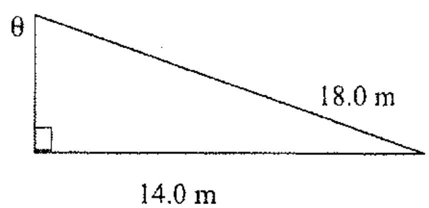
13)



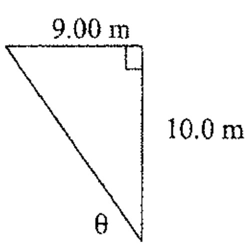
14)



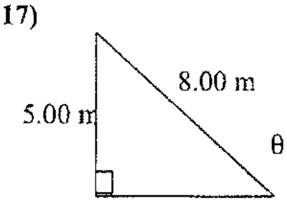
15)



12)

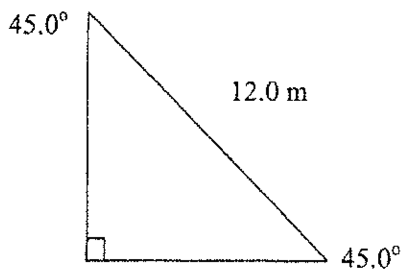


17)

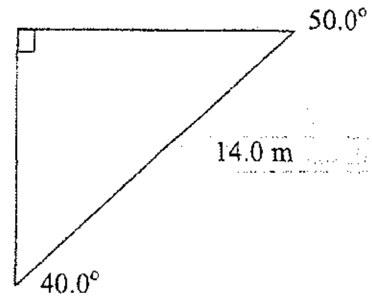


Here's some mixed problems:

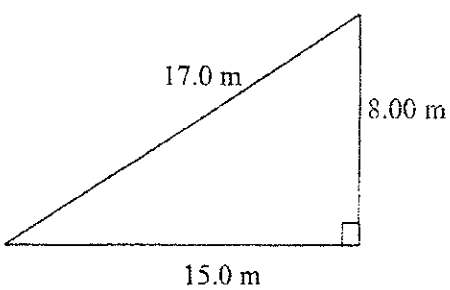
18) Find the remaining sides of the triangle:



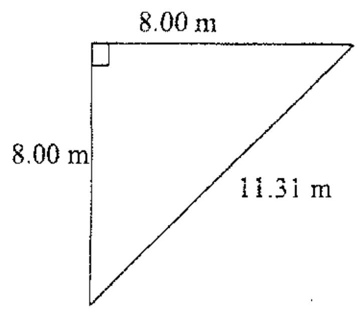
19) Find the remaining sides of the triangle:



20) Find all the angles of the triangle:



21) Find all the angles of the triangle:



Answers

1) 0.000, 1.000, 0.000
2) 1.000, 0.000, undefined
3) 0.500, 0.866, 0.577
4) 0.707, 0.707, 1.000
5) 0.866, 0.500, 1.73

6) 8.66 m
7) 1.41 m
8) 13.9 m
9) 18.7 m

10) 12.0 m
11) 5.00 m

12) 45.0°
13) 30.0°
14) 53.1°
15) 51.1°
16) 42.0°
17) 38.7°

18) 8.49 m, 8.49 m
19) 9.00 m, 10.7 m

20) 28.1°, 61.9°, 90.0°
21) 45.0°, 45.0°, 90.0°

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 2.00×10^2, 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.

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

b. $K = \frac{1}{2}(6.6\times10^{2}\ kg)(2.11\times10^{4}\ m/s)^2 =$ ____________

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

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

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

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

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

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

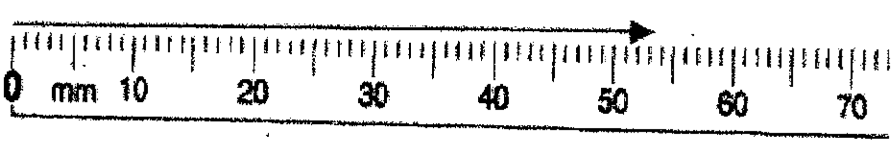
t. $\frac{1}{f} = \frac{1}{s_o} + \frac{1}{s_i}$, $s_i =$ ______________

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 (^{o}C) 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}

$$600 \times 10^{-9}\ m$$

[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* = _______________ ^{o}C

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*

SECTION FOUR: Geometry Review

Solve the following geometric problems.

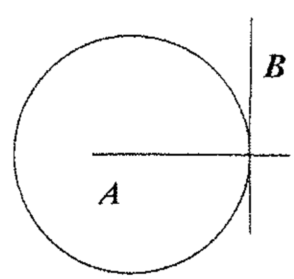
a. Line **B** touches the circle at a single point. Line **A** extends through the center of the circle.

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

   ____

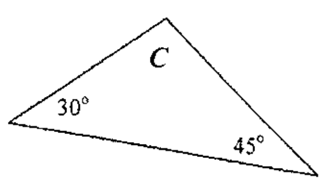
   ii. How large is the angle between lines **A** and **B**?

   ____



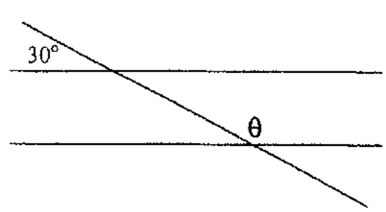
b. What is angle **C**?

____



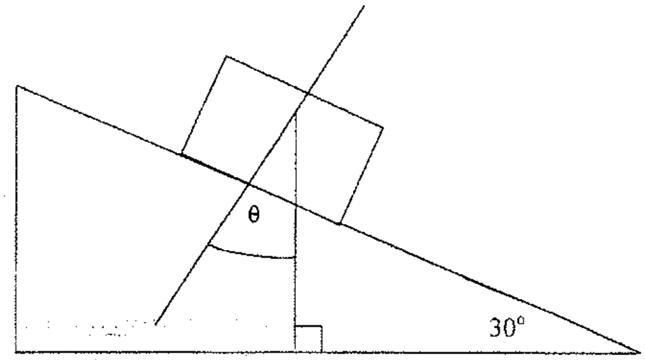
c. What is angle θ ?

____



d. How large is θ?

____



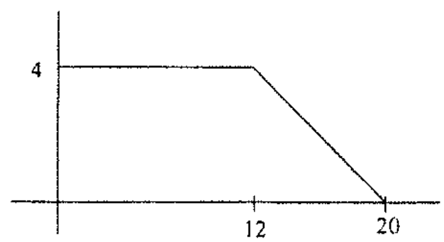
e. The radius of a circle is 5.5 *cm*.

i. What is the circumference in meters?

____

ii. What is its area in square meters?

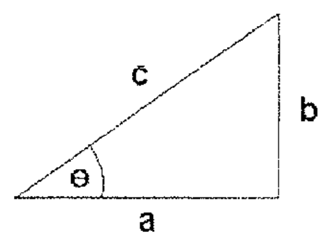
____



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

____

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



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

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

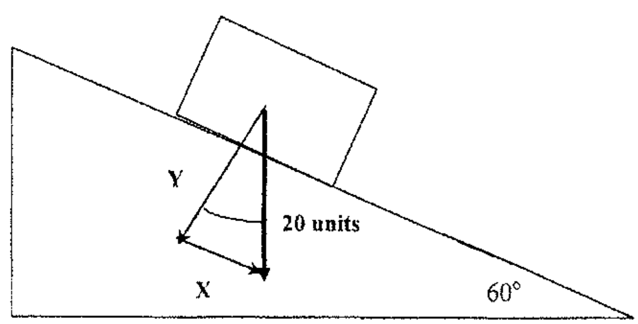
c. $a = 250\ m$ and $b = 180\ m$, solve for θ and c.

d. $a = 25\ cm$ and $c = 32\ cm$, solve for 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 = ______________________



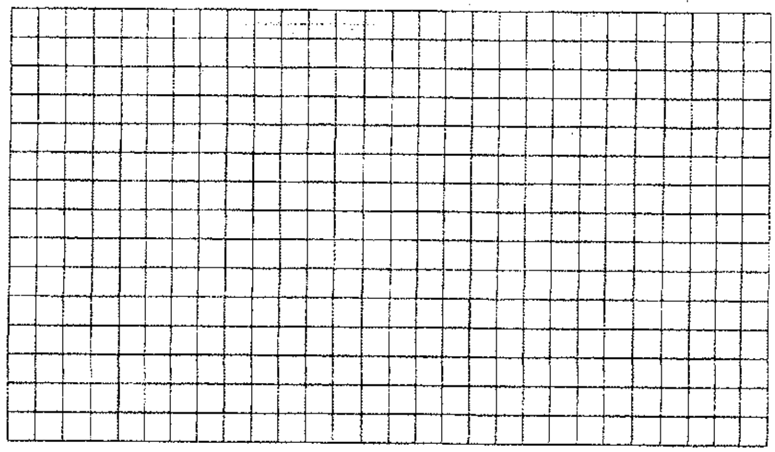
SECTION FIVE: Graphical Analysis

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

AP Physics B Summer Assignment

Read all information carefully and complete all problems. You must show your work for the problems to receive credit. Work may be shown on a separate sheet of paper if necessary.

Plot position vs. time on the axes below.

Time	Position
0.0 s	0.0 m
1.0 s	4.1 m
2.0 s	15.8 m
3.0 s	36.2 m

On your graphing calculator, create this plot and find the equation of the best fit curve. Record this best-fit equation below.

This graph has a changing slope. What does its slope represent?

This quadratic function can be "linearized" by squaring the time values, and plotting position vs. time squared. Try this with this data.

Find the equation of this best fit line on your graphing calculator. Record the equation of this best fit curve below.

Find the slope of this graph (use correct units). What does it represent?

AP Physics B Summer Assignment

Read all information carefully and complete all problems. You must show your work for the problems to receive credit. Work may be shown on a separate sheet of paper if necessary.

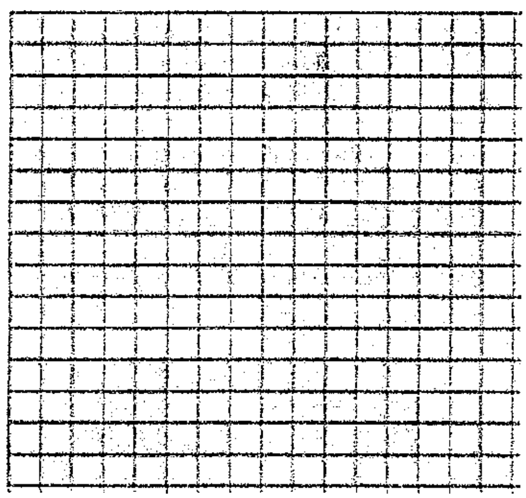
Graphing and Graph Interpretation

You should be familiar with graph construction (by hand and on a calculator). 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 first thing goes on the y-axis. The second 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 m
1.0	5.1 m
2.0	9.9 m
3.0	15.2 m



Draw the best fit line through your data points. Use a graphing calculator to plot the graph. Record the equation of the best-fit line. What is the slope of the line that you plotted (with correct units)?

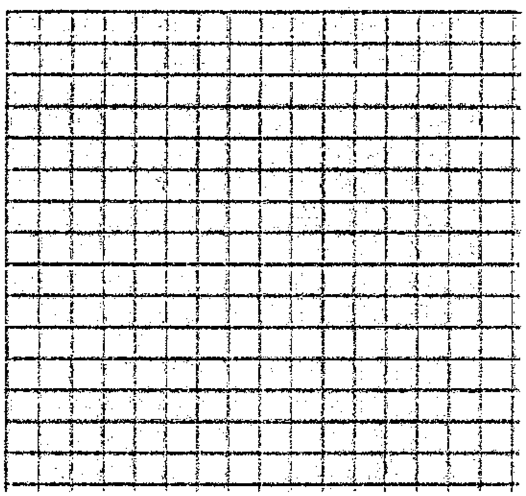
AP Physics B Summer Assignment

Read all information carefully and complete all problems. You must show your work for the problems to receive credit. Work may be shown on a separate sheet of paper if necessary.

Other function types.

The results of a class experiment investigating the relationship between mass and acceleration are shown in the table below. The force applied to each mass was the same.

Mass (kg)	Acceleration (m/s^2)
1.0	6.00
2.0	3.00
3.0	2.00
4.0	1.50
4.8	1.25
6.0	1.00



a. Plot the values given and draw the curve that best fits the points.

b. What is the relationship between mass and acceleration produced by a constant force (describe the plot you created in a.)?

c. What can you say about the relationship between the values for mass and those for acceleration? Use a graphing calculator to find the equation of the best-fit curve to your data. Record it below.

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 $\xrightarrow{\vec{A}}$ — <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.

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

Vector Addition and subtraction

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

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

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.

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

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.

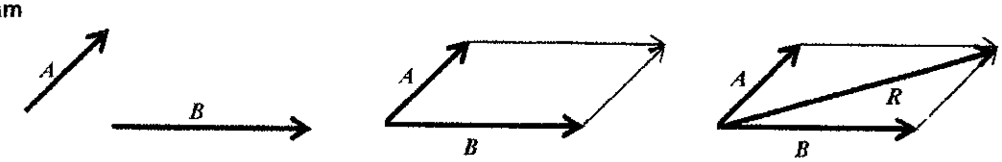
This is very important. In physics a negative number does not always mean a smaller number. Mathematically –2 is smaller than +2, but in physics these numbers have the same magnitude (size), they just point in different directions (180° apart).

<u>Vectors in 2 dimensions</u>

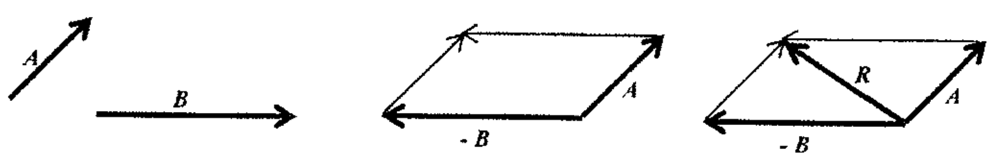
There are two methods of adding vectors in 2 dimensions

Parallelogram

A + B



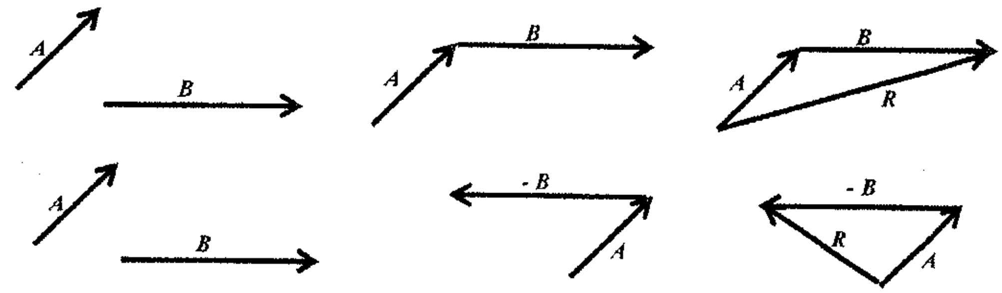
A – B



Tip to Tail

A + B

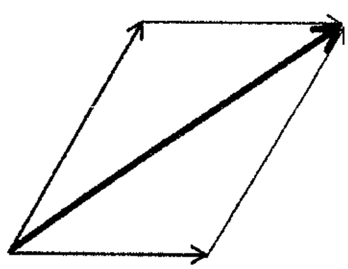
A − B



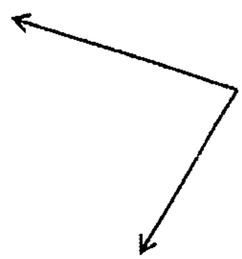
It is readily apparent that both methods arrive at the exact same solution since either method is essentially a parallelogram. It is useful to understand both systems. In some problems one method is advantageous, while in other problems the alternative method is superior.

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

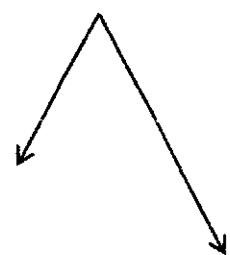
Example



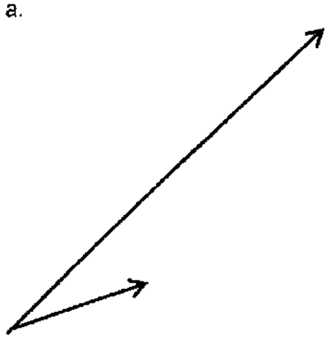
b.



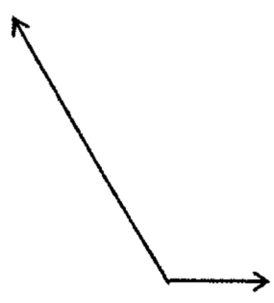
d.



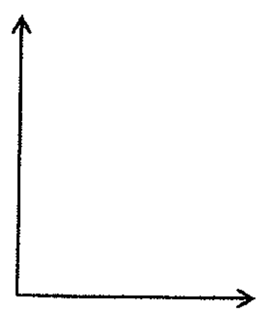
a.



c.

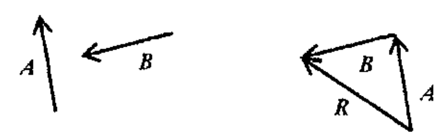


e.

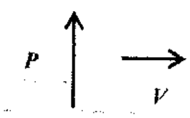


Draw the resultant vector using the tip to tail method of vector addition. Label the resultant as vector ***R***

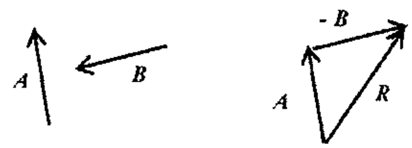
Example 1: ***A* + *B***



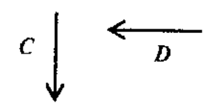
h. ***P* + *V***



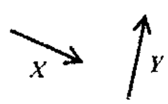
Example 2: ***A* – *B***



i. ***C* – *D***

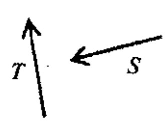


f. ***X* + *Y***



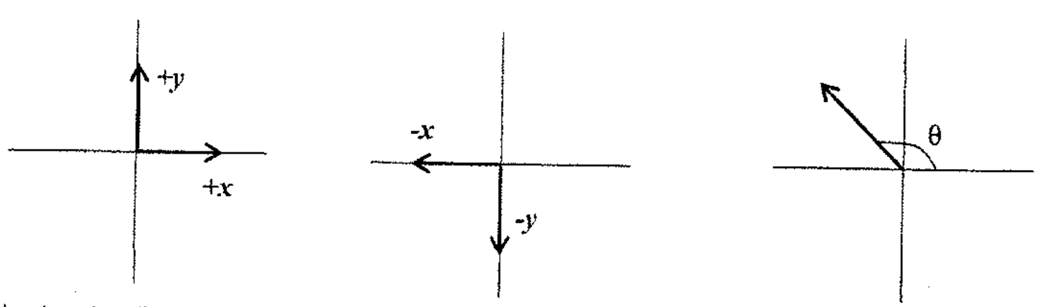
j. ***A* + *B* + *C***

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).

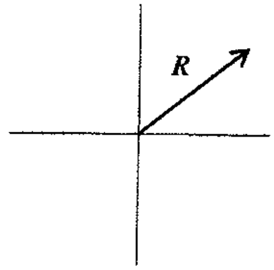


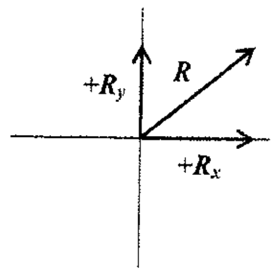
What about vectors that don't fall on the axis? You must specify their direction using degrees measured from East.

Component Vectors

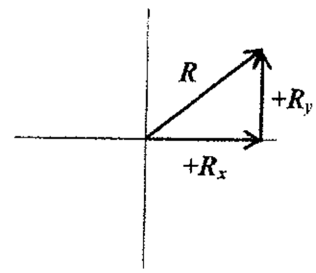
A resultant vector is a vector resulting from the sum of two or more other vectors. Mathematically the resultant has the same magnitude and direction as the total of the vectors that compose the resultant. Could a vector be described by two or more other vectors? Would they have the same total result?

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.





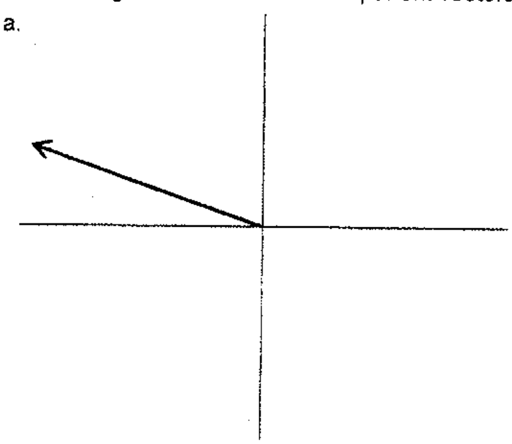
or



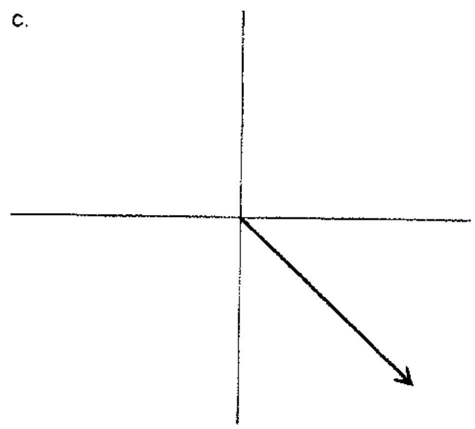
Any vector can be described by an *x* axis vector and a *y* axis vector which summed together mean the exact same thing. The advantage is you can then use plus and minus signs for direction instead of the angle.

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

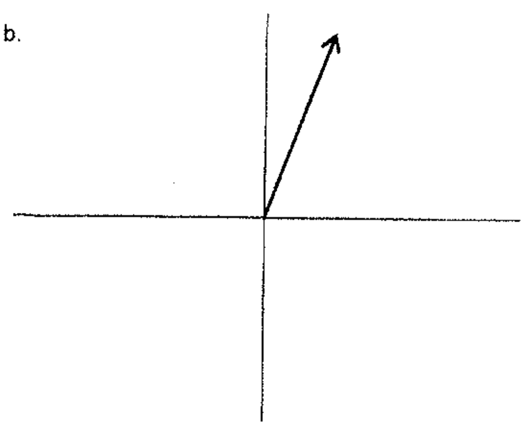
a.



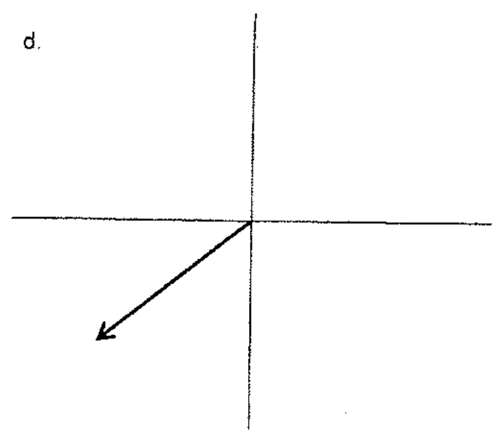
c.



b.



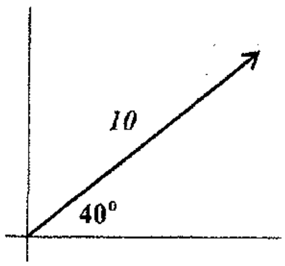
d.

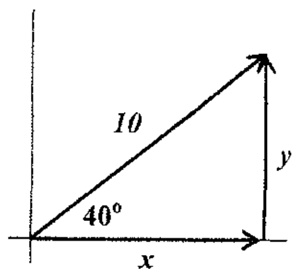


Obviously the quadrant that a vector is in determines the sign of the *x* and *y* component vectors.

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.





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

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

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

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

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

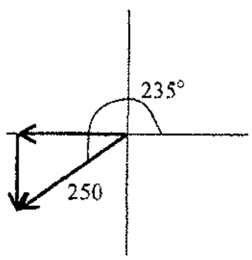
Solve the following problems. You will be converting from a polar vector, where direction is specified in ***degrees measured counterclockwise from east***, to component vectors along the *x* and *y* axis. Remember the plus and minus signs on your answers. They correspond with the quadrant the original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

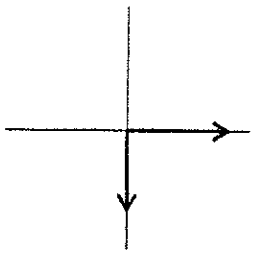
c. 0.00556 at 60°

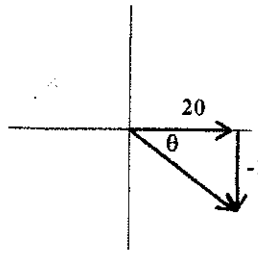
d. $7.5\text{x}10^4$ at 180°

e. 12 at 265°

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





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

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

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

$$R = 25$$

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

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

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

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

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

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

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.

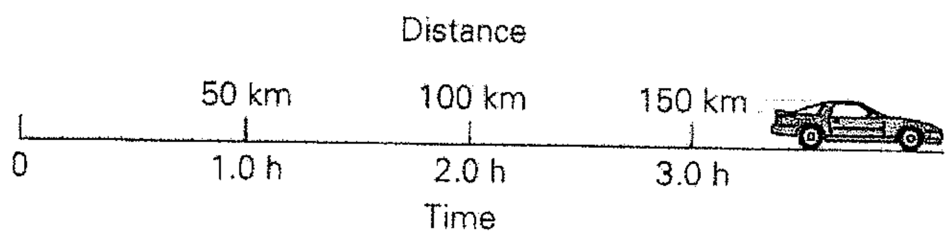
AVERAGE VELOCITY

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

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!)