AP Physics   Name ___________________________

Math Review and Summer Work 2023

I. Physics, and AP Physics in particular, requires a proficiency in algebra, trigonometry, and geometry. In addition to the science concepts, Physics often seems like a course in applied mathematics. The following assignment includes mathematical problems that are considered routine in AP Physics. This includes knowing several key metric system conversion factors and how to employ them. Understanding vectors is another key mathematical area used in Physics. You may recognize some part 1 materials from Honors Physical Science.

II. The attached pages contain both math review and links to introductory physics tutorials and a summer problem set (on p4) of 34 problems on vectors and motion. It is hoped that these tutorials and problems, (combined with your previous math and science knowledge), will give you a head start to very rigorous AP Physics course.

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

A. Do the best you can, but show some work / effort in order to receive credit.

B. You can communicate with me (Mr. Beck) via email: dbeck@fenwickfalcons.org

C. Come to class with your questions ready, in order to resolve these issues.

1. The following are ordinary physics formulas, with numbers in place of the variables normally seen. 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 2.00x10^2, but 2.00x10^8 is easier to write than 200,000,000). Do your best to cancel units, and attempt to show the simplified units in the final answer.

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

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

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

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

e. $e = \dfrac{1.7\times10^{3}\ J - 3.3\times10^{2}\ J}{1.7\times10^{3}\ J} = ?$ [this ratio has no units. Express it as a percentage]. ______________%

f. $1.33\sin 25.0° = 1.50\sin\theta$ $\theta = ?$ ______________

g. $K_{max} = \left(6.63\times10^{-34}J\cdot s\right)\left(7.09\times10^{14}s\right) - 2.17\times10^{-19}J\cdot s^2 = ?$ ______________

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.

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

OR $t =$ _______________

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

[You should find a common denominator, first]

2. As you remember from Physical Science, Physics uses the ***MKS*** system (***SI***: System Internationale). ***MKS*** stands for meter, kilogram, second. The equations in physics depend on unit agreement, so you must convert to ***MKS*** in most problems to arrive at the correct answer. Sometimes you may need to convert to or from alternative systems, such as the **CGS** version (centimeter, gram, second) of SI still popular in the United Kingdom. For example, in MKS SI, energy is measured in Joules, where 1 J = 1 kg m^2/s^2. In **CGS** SI energy is measured in ergs, where 1 erg = 1 g cm^2/s^2. Sometimes it is convenient to use still different units of energy, such as calories, where 1 calorie is defined as the amount of energy to raise 1 g of water by 1 Celsius degree in temperature. Despite the occasional exception, most of the work we do will use **MKS** SI units.

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 meters to nanometers
micrometers (μm) to meters (*m*)
gram (*g*) to kilogram (*kg*)
Celsius (^oC) to Kelvin (*K*)
atmospheres (*atm*) to Pascals (*Pa*)
liters (*L*) to cubic meters (m^3)

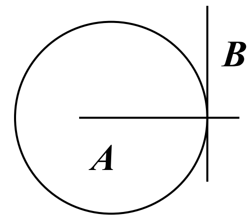
Other conversions will be taught as they become necessary.

3. 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;-) Some smartphone apps exist to solve this common problem, too, but you won't have access to them on exams. I usually put common conversion factors on a formula sheet I pass out with quizzes and tests. Practice the following conversions, looking up ones you don't already know:

a. 4008 *g* = _______________ *kg*
b. 1.2 *km* = _______________ *m*
c. 823 *nm* = _______________ *m*
d. 298 *K* = _______________ ^oC
e. 0.77 *m* = _______________ *cm*
f. $8.8\text{x}10^{-8}$ *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. $6.23\text{x}10^{-7}$ *m* = _______________ *nm*
n. $1.5\text{x}10^{11}$ *m* = _______________ *km*

4. Remember these from HPS Summer work? You should still know them!

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?

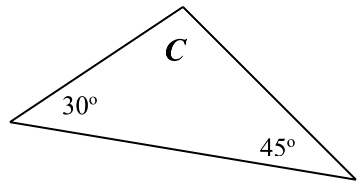
____

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

____

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

____



c. What is angle θ ?

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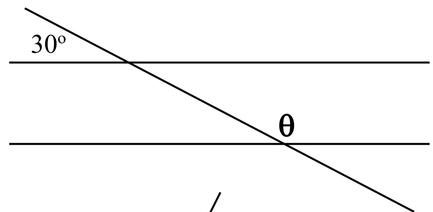

d. How large is *θ*?

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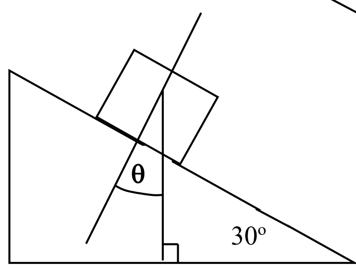

e. The radius of a circle is 5.5 *cm*,

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

____

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

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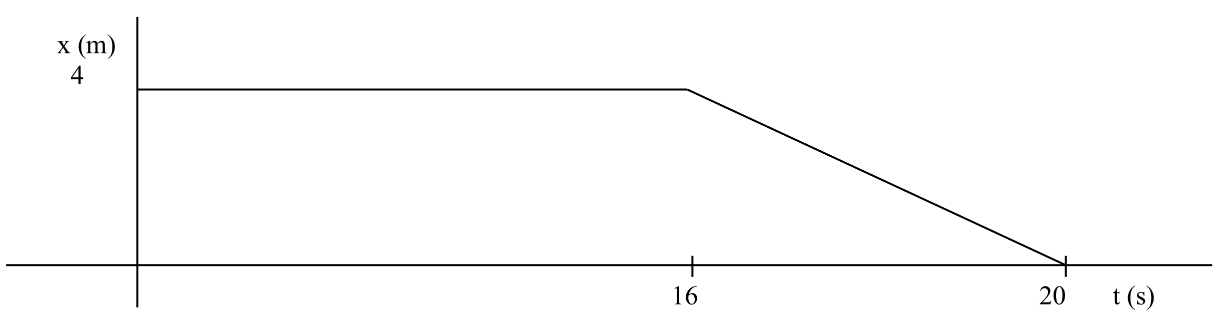
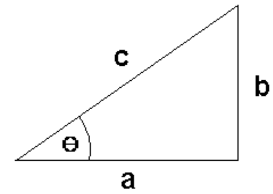
f. What is the area under the curve below? ___________



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



a. θ = 55° and ***c*** = 32 *m*, solve for ***a*** and ***b***.

____

b. θ = 45° and ***a*** = 15 *m/s*, solve for ***b*** and ***c***.

____

c. ***b*** = 17.8 *m* and θ = 65°, solve for ***a*** and ***c***.

____

d. ***a*** = 250 *m* and ***b*** = 180 *m*, solve for θ and ***c***.

____

e. ***a*** =25 *cm* and ***c*** = 32 *cm*, solve for ***b*** and θ.

____

f. ***c*** =104 *cm* and ***b*** = 65 *cm*, solve for ***a*** and θ.

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Additional Vectors Review: The last 2 pages of this document are taken from the HPS Summer Work that you should remember how to do. You should do them before attempting the Application Problems.

If you feel rusty with these representations of vectors let me know and I'll want to send you additional resources to get caught back up.

If you're good on all of the above, proceed to the last part of the summer work for AP Physics: Some real physics problems to solve!

Application Problems with vectors

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

If you need reminders about vectors, look through the tutorials on vectors at the website: http://www.physicsclassroom.com/Class/vectors/

1D Kinematics Practice Problems

To get a head start beyond vector fundamentals, to solve actual problems where vectors must be used, read the following tutorials and complete the **Summer Problem Set Assignment** mentioned below:

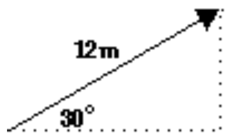
a. Introduction to the Language of Kinematics
b. Scalars and Vectors
c. Distance and Displacement
d. Speed and Velocity
e. Acceleration

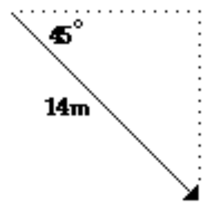
Summer Problem Set Assignment: (34 problems, due the 2nd class meeting of the year)

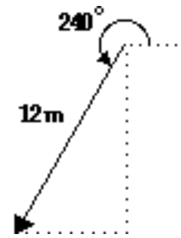
Go to http://www.physicsclassroom.com/calcpad/vecproj/problems and complete the 34 problems on this page, showing your handwritten, neatly organized work on sheets of notebook paper. Each problem can be checked while online for a correct answer and an audio guide to the solution, if further help is needed. Show all steps of your solution, not just answers!! Most of these are 2-D kinematics problems. Give them your best shot!

Vectors and Projectiles

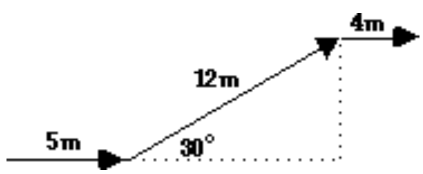
3. A component is the effect of a vector in a given x- or y- direction. A component can be thought of as the projection of a vector onto the nearest x- or y-axis. SOH CAH TOA allows a student to determine a component from the magnitude and direction of a vector. Determine the components of the following vectors.

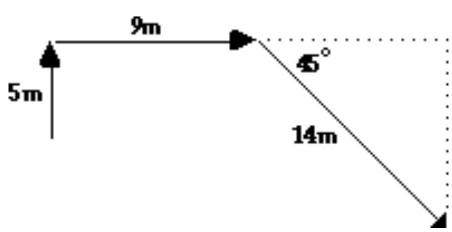






4. Consider the following vector diagrams for the displacement of a hiker. For any *angled* vector, use SOH CAH TOA to determine the components. Then sketch the resultant and determine the magnitude and direction of the resultant.





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Vector Representation

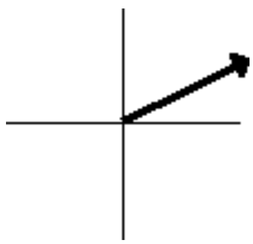
Read from **Lesson 1** of the **Vectors and Motion in Two-Dimensions chapter** at **The Physics Classroom**:

http://www.physicsclassroom.com/Class/vectors/u3l1a.html

MOP Connection: Vectors and Projectiles: sublevel 1

Vector quantities are quantities that have both magnitude and direction. The direction of a vector is often expressed as a counter-clockwise angle of rotation of that vector from due east (i.e., the horizontal). For questions #1-6, indicate the direction of the following vectors.

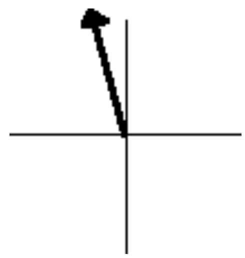
1.



CCW Dir'n: __________

magnitude: __________

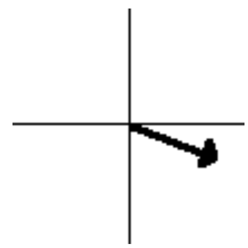
2.



CCW Dir'n: __________

magnitude: __________

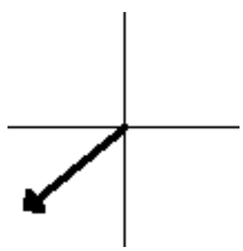
3.



CCW Dir'n: __________

magnitude: __________

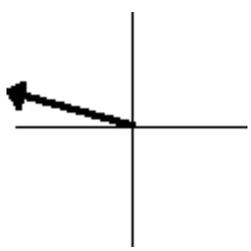
4.



CCW Dir'n: __________

magnitude: __________

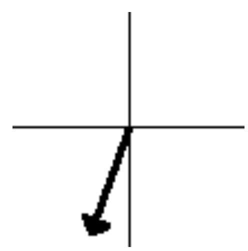
5.



CCW Dir'n: __________

magnitude: __________

6.



CCW Dir'n: __________

magnitude: __________

7. The above diagrams are referred to as scaled vector diagrams. In a scaled vector diagram, the magnitude of a vector is represented by its length. A scale is used to convert the length of the arrow to the magnitude of the vector quantity. Determine the magnitude of the above six vectors if given the scale: 1 cm = 10 m/s.