Highland School
Honors Physics
Summer Assignment

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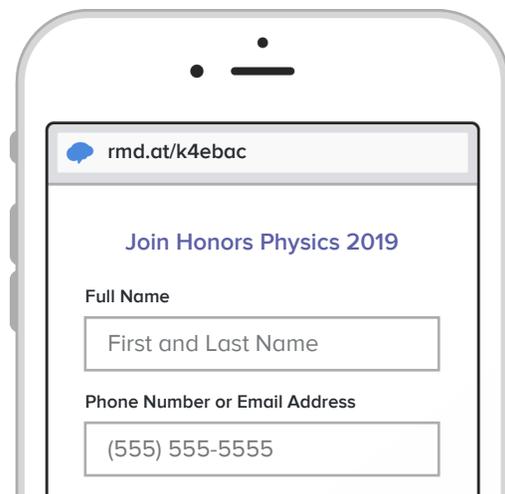Get information for **Highland School** right on your phone—not on handouts.

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Instructions to the Student:

This document describes the mathematics skills you will need to be successful in Honors Physics. Physics attempts to understand, explain, justify, and quantify the behavior of objects that you can observe (and some objects that you can't observe).

Physics speaks in the language of mathematics: symbols, numbers, units, and angles. As a result, it is necessary for you to be able to do algebra, rudimentary trigonometry, unit conversions, dimensional analysis, simplification of expressions of numbers and units, scientific notation, and graphing.

It must be understood that these skills will be tested for specifically on the last class of the week of the second week of school. HOWEVER, THESE SKILLS WILL THEN BE TAKEN FOR GRANTED *FROM THAT POINT FORWARD*. These skills are absolutely required. If you are not comfortable doing this mathematics, you have two choices: get comfortable, or struggle for the rest of the year.

This assignment is due on the first day class meets in September. It will be checked for completion and you will also write out selected problems for scoring.

Part 1: Scientific Notation & Significant Figures

The following are ordinary physics problems. Write the answer in scientific notation, simply the units, and use the correct number of significant figures.

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

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

c. $\dfrac{1}{R_p} = \dfrac{1}{4.5\times10^2\,\Omega} + \dfrac{1}{9.4\times10^2\,\Omega}$ $\qquad\qquad$ $R_p = $ _____

d. $K_{max} = (6.67\times10^{34}J\cdot s)/(7.09\times10^{14}s) - 2.17\times10^{19}J$ $\quad$ $K_{max} = $ _____

e. $\gamma = 1\left/\sqrt{1 - \dfrac{2.25\times10^8\,m/s}{3.00\times10^8\,m/s}}\right.$ $\qquad\qquad$ $\gamma = $ _____

f. $K = \dfrac{1}{2}(6.6\times10^2 kg)(2.11\times10^4\,\tfrac{m}{s})^2$ $\qquad\qquad$ $K = $ _____

g. $(1.33)sin25.0° = (1.50)sin\theta$ $\qquad\qquad$ $\theta = $ _____

Part 2: Solving Equations

Often problems in Honors and AP Physics are done with variables only. Solve for the variable indicated. Do not let the different variables confuse you. Manipulate them algebraically as though they were numbers.

a. $K = \frac{1}{2}mx^2$ $x =$

b. $p = 2\pi\sqrt{\frac{l}{g}}$ $g =$

c. $F_g = G\frac{m_1 m_2}{r^2}$ $r =$

d. $mgh = \frac{1}{2}mv^2$ $v =$

e. $x = x_0 + v_0 t + \frac{1}{2}at^2$ $t =$

f. $B = \frac{\mu_0 I}{2\pi r}$ $r =$

g. $x_m = \frac{m\lambda L}{d}$ $d =$

h. $pV = nRT$ $=$

i. $\sin\theta_c = \frac{n_1}{n_2}$ $\theta_c =$

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

Part 3: Unit Conversions

Science uses the **SI** (System Internationale). For this class, we most often use **KMS** (kilogram, meter, second). The equations in physics depend on unit agreement, so you must covert to **KMS** in most problems to arrive at the correct answer.

Conversions that you should know off the top of your head:
- kilometers (*km*) to meters (*m*) and meters to kilometers
- centimeters (*cm*) to meters and meters to centimeters
- millimeters (*mm*) to meters and meters to millimeters
- nanometers (*nm*) to meters and meters to nanometers
- micrometers (*μm*) to meters and meters to micrometers
- grams (*g*) to kilograms (*kg*) and kilograms to grams
- Celsius (°*C*) to Kelvin (*K*) and Kelvin to Celsius
- atmospheres (*atm*) to Pascals (*Pa*) and Pascals to atmospheres
- liters (*L*) to cubic meters (*m³*) and cubic meters to liters
- 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: Use the Googles…

Use correct significant figures for ALL answers.

a. 4008 *g* = _____ *kg*

b. 1.2 *km* = _____ *m*

c. 823 *nm* = _____ *m*

d. 298 *K* = _____ °*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. 40.0 *cm* = _____ *m*

l. 6.23×10^{-7} *m* = _____ *nm*

m. 1.5×10^{11} *m* = _____ *km*

Part 4: Geometry

Solve the following geometric problems.

a. Line **B** touches the circle at a single point. Line **A** extends through the center of the circle.
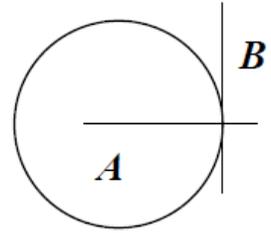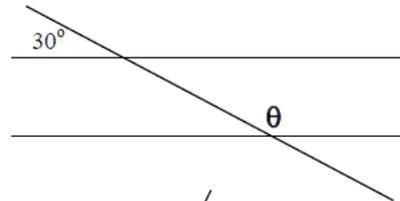
    i.   What is line **B** in reference to the circle? _____

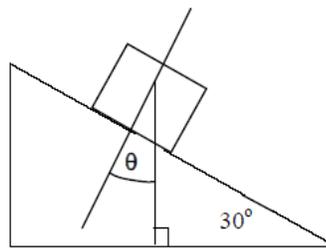   ii. How large is the angle between lines **A** and **B**? _____

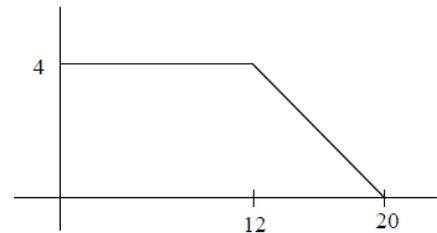b. What is angle **C**? _____
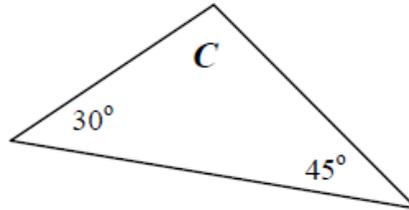
c. What is angle **θ**? _____

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? _____

Part 3: Trigonometry

Using the generic triangle to the right, right triangle trigonometry (SOHCAHTOA), and Pythagorean Theorem solve the following problems. Use correct significant figures.
Hint: Because the angles are measured in degrees, **your calculator must be in degree mode!**

a. θ = 55° and c = 32 m, solve for a and b.
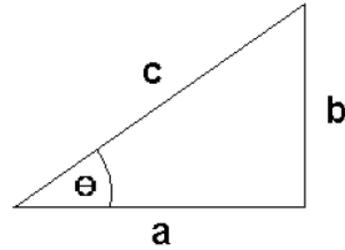
b. θ = 45° and a = 15 m, solve for b and c.

c. θ = 65° and b = 17.8 m, 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 θ and b.

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

Part 6: Vectors

Most of quantities in physics are vectors. **This makes proficiency in vectors extremely important!**

Magnitude: Size or extend. 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, temperature
Vectors: A physical quantity with both magnitude and direction. A directional quantity.
     Examples: velocity, acceleration, force

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

Negative Vectors: Negative vectors have the same magnitude as the positive counterpart. They are just pointing in the opposite direction by 180°.

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

Vector Addition and Subtraction
     Think of a vector at addition only. The result of adding vectors is called the <u>resultant</u>. $\vec{R}$

$\vec{A}+\vec{B}=\vec{R}$ $\xrightarrow{\vec{A}}$ + $\xrightarrow{\vec{B}}$ = $\xrightarrow{\qquad\vec{R}\qquad}$
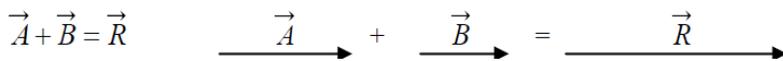
     So, if **A** has a magnitude of 3 and **B** has a magnitude of 2, then **R** has a magnitude of 3+2=5.

     When you need to subtract one vector from another think of the one being subtracted as a negative vector and add them.
          So, if **A** has a magnitude of 3 and **B** has a magnitude of 2, then **R** has a magnitude of 3+(-2)=1.
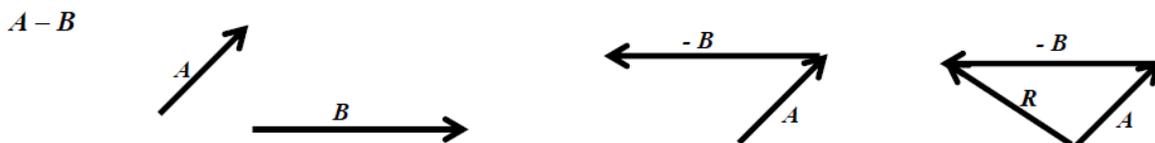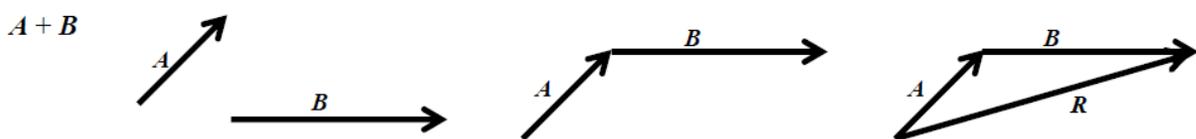
<u>**THIS IS VERY IMPORTANT!**</u> In physics, a negative number does not always mean a smaller number. Mathematically, -2 is smaller than +2. But in physics, if these quantities are vectors, they have the same magnitude (size), they just point in different directions.

     There are two methods of adding vectors:
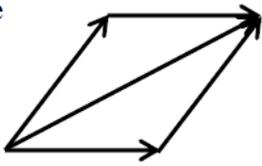
Parallelogram
$A+B$

$A-B$

Tip to Tail
$A+B$

$A-B$
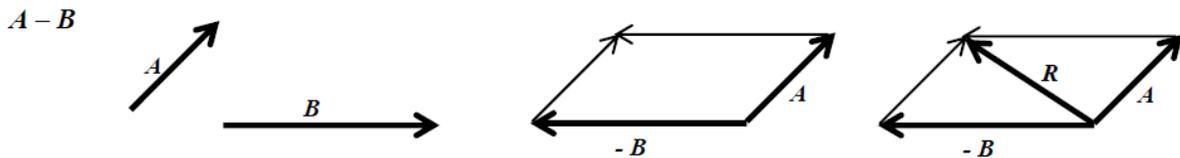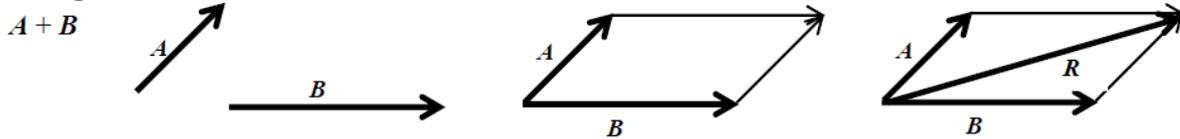
Part 7: Drawing Resultant Vectors

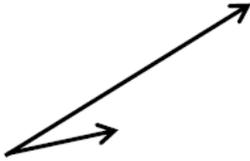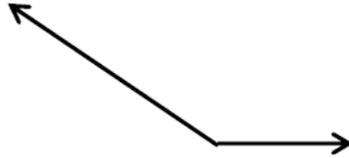Draw the resultant vector using the parallelogram method of vector addition.
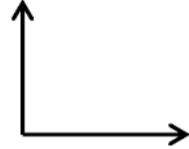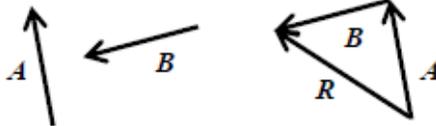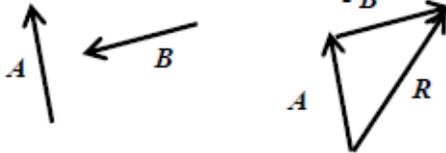
Example

b.

d.

a.

c.

e.

Draw the resultant vector using the tip to tail method of vector addition.

Example 1: $A + B$

B

R

A

Example 2: $A - B$

A

B

$- B$

A

R

f. $X + Y$

X

Y

g. $T - S$

T

S

h. $P + V$
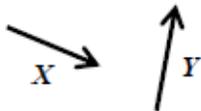
P

V

Part 8: Vector Components/Resolving 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. This process is known has "resolving a vector".
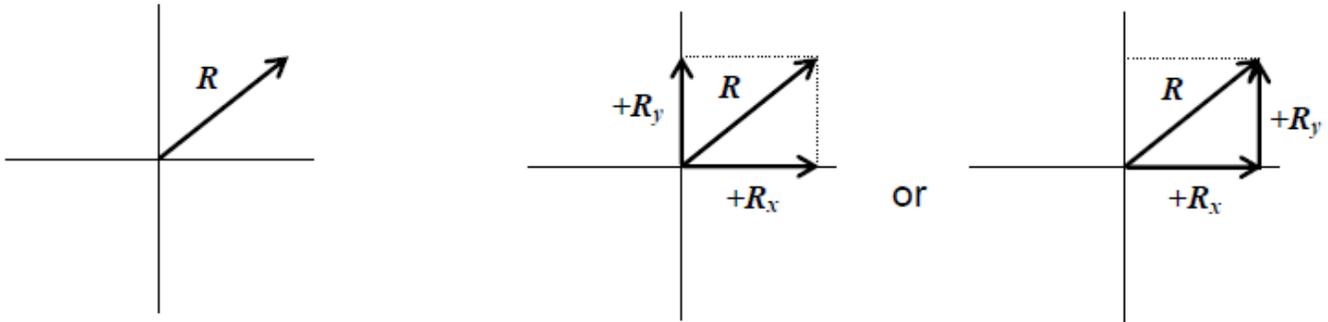
For the following vectors, draw the components along the *x* and *y* axis.

a.

c.

b.

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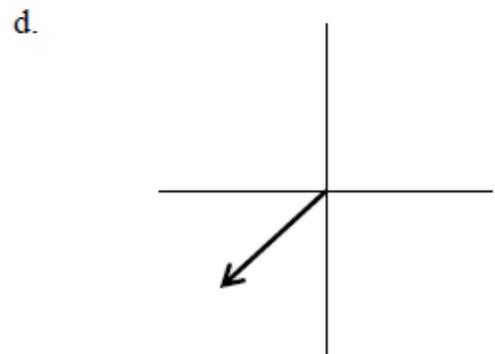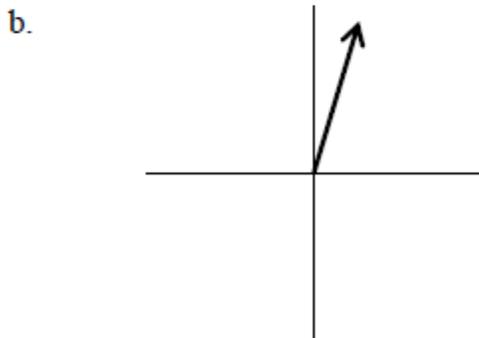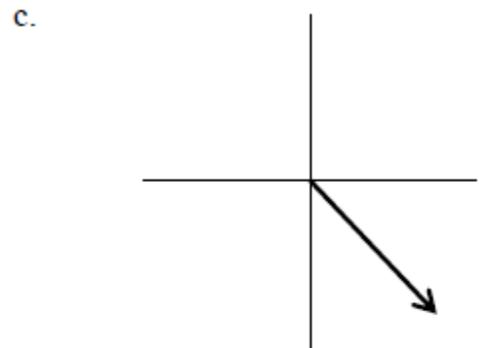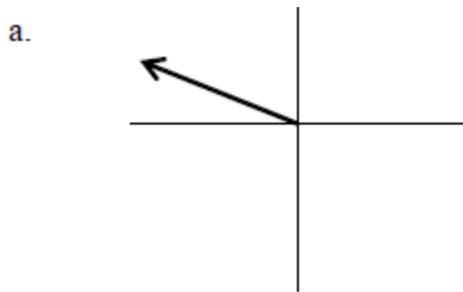
Obviously, the quadrant that a vector is in determines the sign of the *x* and *y* component vectors.