AP Physics Summer Assignment

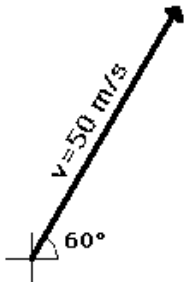
Name_____

Date _____ Bk ____

The purpose of this summer assignment is to allow you to become familiar with some of the mathematical tools of physics. Physics is not a math class, but math can often be used to describe physical phenomena so we will use it frequently. Answers for checking your work are on the last page.

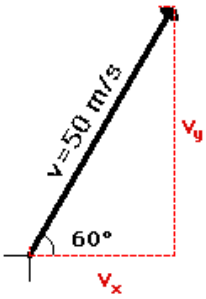
Part 1: Vectors

One of the most used mathematical concepts in physics is the **vector**. A vector is a quantity that has both magnitude (size) and direction. For example, the vector to the right represents the velocity of an object at 50 m/s (magnitude) at an angle of 60° (direction).



Oftentimes we will be interested in just determining the size of one of the **components** (parts) of the vector. A vector can have both horizontal and vertical components. For example, an object traveling at 50 m/s at an angle of 60°, is traveling both in the horizontal and vertical directions. How do we determine the amount though? We know from trigonometry that

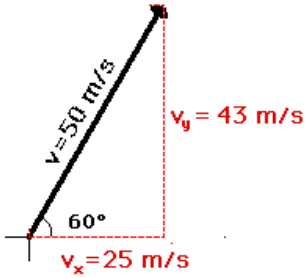
$$\cos\theta = \frac{v_x}{v} \quad \text{and} \quad \sin\theta = \frac{v_y}{v}$$



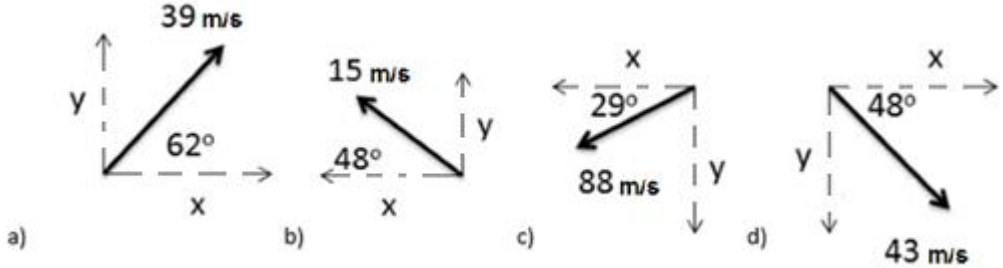
Rearranging we get the basic equations for getting vector components.

$$v_x = v\cos\theta \quad \text{and} \quad v_y = v\sin\theta$$

Check for yourself that that the values in the figure to the right are correct.



1. What are the x and y components of the force vectors shown below? Also, do not concern yourself with negative numbers at this point.
   PSYW (Please show your work!)



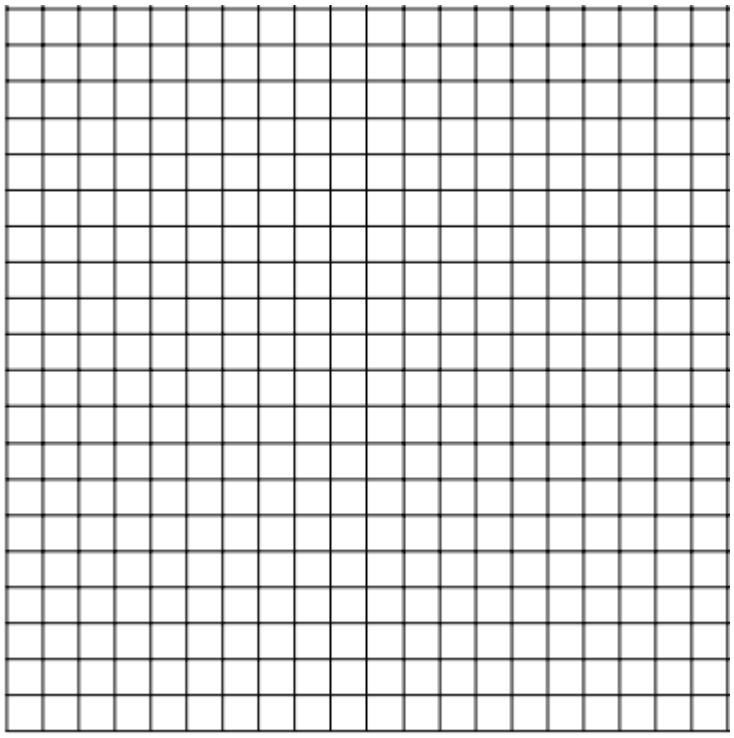
Part 2: Mathematical Models

One of the most useful tools of physics is the mathematical model. A mathematical model is an equation that represents the relationship between two or more variables. In AP Physics 1, all of the equations you will use will be created by you from lab data.

For example, a student wanted to experimentally determine the relationship between a circle's diameter and its circumference. Here is the data that student collected.

Diameter (cm)	Circumference (cm)
5.0	15.7
10.0	31.4
15.0	47.1
20.0	62.8
25.0	78.5

2. Graph the data and draw a line of best fit. Make sure to plot diameter on the x-axis and circumference on the y-axis. Make sure to label your axes.



3. Create an equation in the form y = mx + b for the resulting line, where y is the variable on the y-axis, m is the slope, x is the variable on the x-axis, and b is the y-intercept.

4. What does the slope of this line represent? Hint: The national holiday is celebrated on March 14^{th} each year.

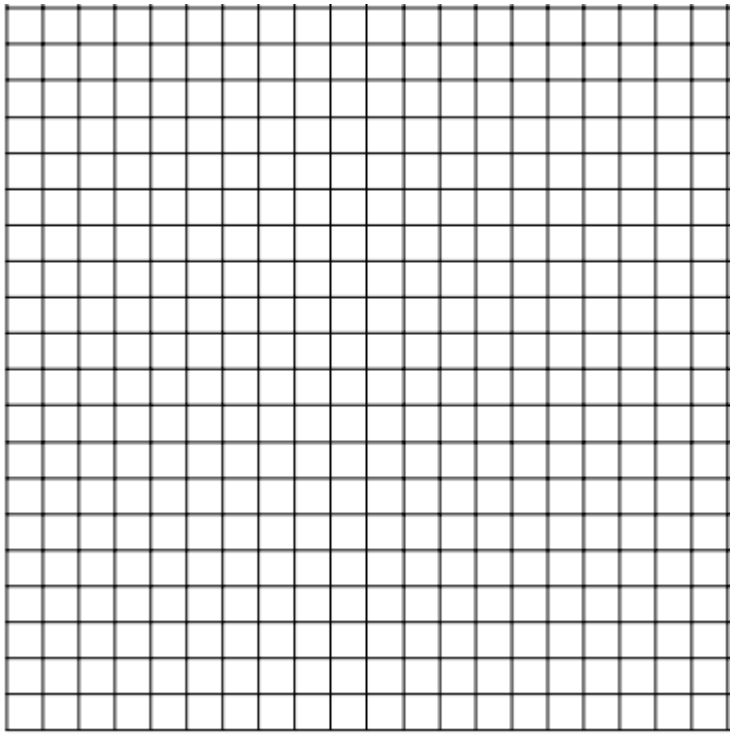
Part 3: Linearization

How do we create a mathematical model for a line that isn't straight?

For example, a student wanted to experimentally determine the relationship between a circle's area and its radius. Here is the data that student collected.

radius (cm)	area (cm^2)
5.0	78.5
10.0	314.2
15.0	706.9
20.0	1256.6
25.0	1963.5

5. Graph the data on the graph below and draw a line of best fit. Make sure to plot diameter on the x-axis and circumference on the y-axis. Don't forget to label your axes.



6. What shape is the line?

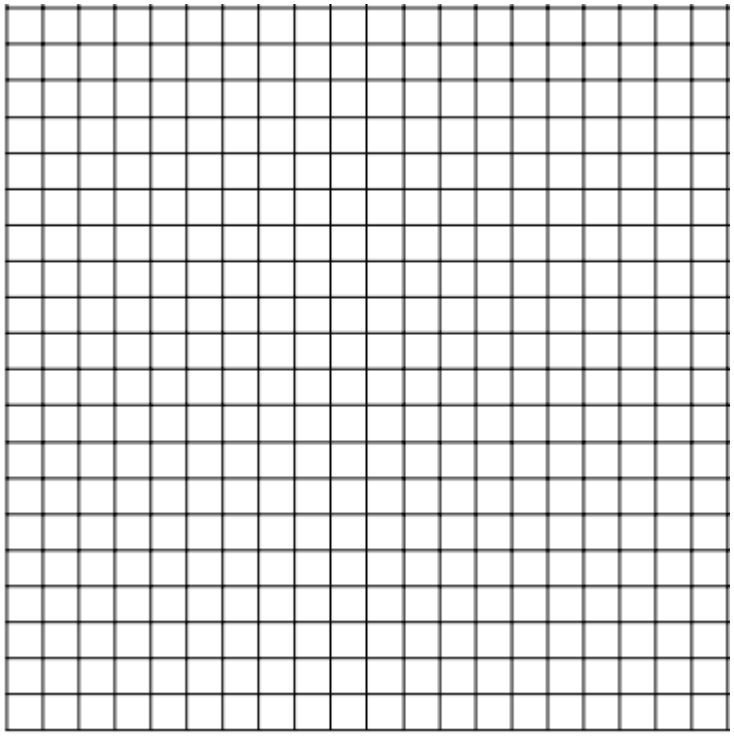
Hopefully you noticed that the line wasn't straight. It is difficult to get the equation for a line that isn't straight unless you have a computer. Or unless you know how to use linearization, which is the process of transforming a curvy line into a straight line so that you can analyze it. How does that work?

The line in the previous graph looks like a parabola. We know from math class that a parabola can be represented by the equation $y = Ax^2$, where A is some constant.

7. Try this: since radius was on the x-axis in the last graph, calculate the values of radius^2.

radius (cm)	radius^2 (cm^2)	area (cm^2)
5.0		78.5
10.0		314.2
15.0		706.9
20.0		1256.6
25.0		1963.5

8. Now graph area vs. radius^2, i.e. put area on the y-axis and radius^2 on the x-axis.



9. Create an equation in the form y = mx + b for the resulting line, where y is the variable on the y-axis, m is the slope, x is the variable on the x-axis, and b is the y-intercept. Remember that x in this case will be radius^2, not just radius.

To check your answer, compare the equation you created to the equation for the area of a circle. They should be identical.

Answers (mirror not included)

a. 78.3 m/s, 34.4 m/s
b. 10.0 m/s, 11.1 m/s
c. 11.0 m/s, 45.7 m/s
d. 35.0 m/s, 58.8 m/s
e. C = 3.14 D
f. π
g. Parabola
h. A = 3.14 r^2

We will be able to linearize many different graph shapes besides parabolas. Stay tuned!