AP Physics 1 Summer Assignment-2015

Name: ___________________________

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This assignment is due the first day of class. If you have questions or get stuck, you can contact Mrs. Howell (rh@fizziks.info) or Ms. Lang (ml@fizziks.info). Expect up to 48 hrs for a reply, so don't wait until the last minute to start working! Have a nice summer, (in spite of this assignment!) Mrs. Howell & Ms. Lang
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I. Algebra and Trig Review

We will use basic algebra and trig throughout the year to solve physics problems. We'll learn several equations that describe the relationships among variables. Depending on what information is known in a given situation, you may need to rearrange the equation to solve for the unknown of interest. We'll also have to use trig to find the magnitude (fancy word for amount) of a variable in the direction of interest. You'll want to be comfortable with these skills. Review the Algebra & Trig summary pages. Complete the practice problems.

II. Vectors

Many of the quantities in Physics are vectors, which mean they have both magnitude and direction. For example, to fully describe the velocity at which you are traveling you might say that you are traveling at 10 m/s west. Force is another example of a vector. The direction of a force is important. For example, if you are trying to push a stalled car, you would certainly want to apply the force in the direction that you want the car to travel.

You need to show your work to receive credit – don't just write down the answer!

III. Graphing

Graphing is a major component of the development of physics concepts and allows us to create mathematical models for the phenomena we investigate. Being able to create a graph, read a graph and linearize data is essential for your success in this course.

Part I: Algebra Review

Throughout the year, we'll be rearranging formulas and equations to solve for the variable we want to know. Refresh your algebra skills with the following:

Example:

Suppose we want to know the acceleration, a, in the following formula: $\Delta y = v_o t + \frac{1}{2}at^2$

y is the distance
v_o is the initial velocity
t is the time

Isolate the term with the variable of interest, a.

$\Delta y = v_o t + \frac{1}{2}at^2$

$\Delta y - v_o t = \frac{1}{2}at^2$

$\frac{\Delta y - v_o t}{\frac{1}{2}t^2} = a$

Example:

Solve the following.

$6 = \frac{18+3x}{x}$

In this case, we have to get all the terms with x's into 1 term.

Multiply both sides by x.

$6x = 18 + 3x$

$6x - 3x = 18 \;\; 3x = 18$

Divide both sides by 3

$x = 6$

Practice: Solve the following for the unknown variable.

1. $x + 47 = 95$

2. $55 + a = \; -78$

3. $\frac{1}{r} = \frac{1}{5} + \frac{1}{15}$

4. $\frac{1}{32} = \frac{1}{f} + \frac{1}{-8}$

5. $37 = \frac{314.5}{x}$

6. $5 = \frac{3x-4}{x}$

7. $2x = \frac{3x^2 - 16}{x}$

Practice: Solve for the given letter (variable)

1. $A = p + prt$ for t

2. $A = \frac{1}{2}d_1 d_2$ for d_1

3. $f_o = \frac{f_s(v+v_o)}{v-v_s}$ for v_o

4. $y = mx + b$ for m

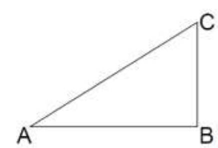
5. $v = \sqrt{(\frac{GM}{r})}$ for r

6. $F = k\frac{Q_1Q_2}{r^2}$ for r

7. $F = \frac{mv^2}{r^2}$ for v

Right Triangles & Trigonometry

Suppose you wanted to get from point A to point C in the following diagram. You could go directly from A to C, or you could go to the right from A to B and then go straight up from B to C. Thus the direction we go is important. We will define the distance from C to A as our displacement. You'll see shortly that the displacement is a vector. In many cases, we will be interested in the x and y component of a vector. In this case, the x component is AB. The y component is BC.



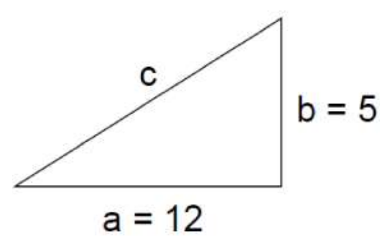
Pythagorean Theorem

If two of the three sides of a right triangle are known, we can find the 3rd side using the Pythagorean Theorem. Recall that $a^2 + b^2 = c^2$

Example:

Find C for the triangle shown right.

$$a^2 + b^2 = c^2 \;\; 12^2 + 5^2 = c^2 \;\; 169 = c^2 \;\; c = 13$$



Right Triangle Trigonometry

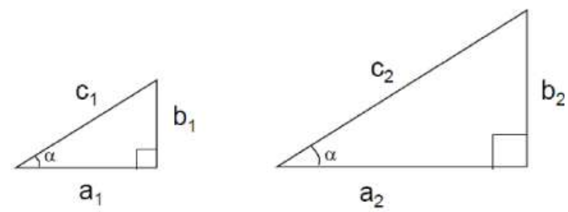
Both of the triangles shown are right triangles. Angle is the same for both. Side **c** is the hypotenuse.

Side **a** is adjacent to angle.

Side **b** is opposite angle.

If we divided side **b** by side **a** for both triangles we would get the same number. The only way we could get a different ratio would be if the angle changed.

For example, if the angle increased, side **b** would have to increase, while side **a** remained the same. That would cause the ratio to increase. We call the ratio of side **b** to side **a** the tangent of the angle. The same logic is true for the ratios of any two sides. We will use three ratios:



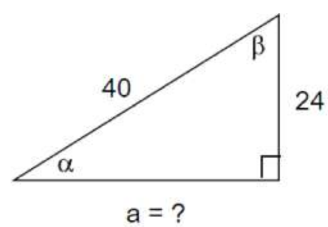
$$\sin \alpha = \frac{b}{c} \quad \cos \alpha = \frac{a}{c} \quad \tan \alpha = \frac{b}{a}$$

Practice: Solve the following.

1. What is the length of side a?

2. What is the sine of angle α?

3. What is the cosine of angle α?

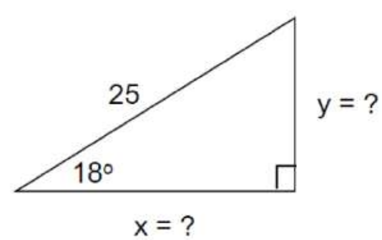


4. Angle α = ___________ degrees

5. Angle β = ____________degrees.

Practice: Solve the following.

1. What is the length of side x?



2. What is the length of side y?

3. Use Pythagorean Theorem to check your answers.

The values for x and y are called the “components” of the vector 25 units at 18 degrees North East. We will be using components all year!

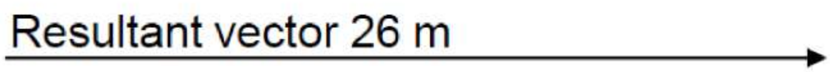
Part II: Vector Addition and Subtraction

Vectors have both magnitude and direction, thus we must take the direction into account when adding or subtracting vectors.

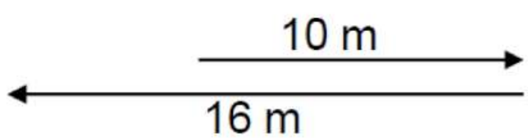
Adding Vectors:

1. The simplest case occurs when vectors are collinear. Vectors are normally represented by arrows. When adding, we used a tail-to-head relationship. Thus the tail of the vector being added to the original vector is placed at the head of the original vector. If they are in the same direction, simply add the magnitudes of the vectors. The direction will be the same as that of the individual vectors.
   For example, if someone walked 10 m East and then 16 meters East, we would draw the vectors as:

The resultant vector would be 26 m East. It is drawn from the tail of the first vector to the head of the second one.

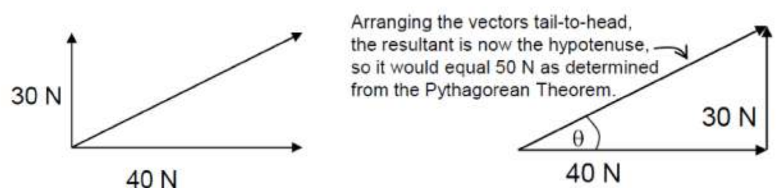


If vectors are in the opposite direction, add them, keeping in mind they have opposite signs.



The resultant vector would be 6 m West.

2. The next simplest case occurs when vectors are perpendicular to each other.. We use the Pythagorean Theorem to add these vectors. For example, if we had a force of 40 N pushing an object due West and a force 30 N pushing an object due North, we know the object would move along a path between the two forces as shown by the line drawn between the two vectors. This is called the **resultant**.



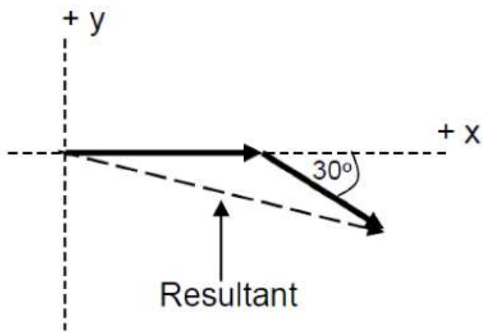
To find the angle, θ , that the resultant force acts along, we can use the inverse tangent function.

$\theta = tan^{-1}\left(\frac{30}{40}\right),\ \theta = 37°$ above the horizontal

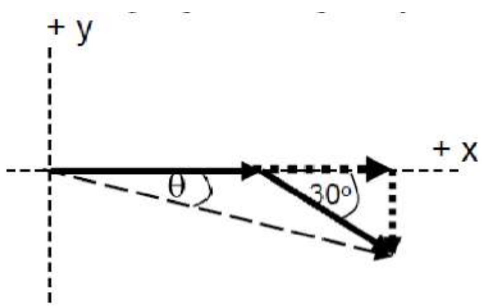
This tells us that the two original forces could be replaced by a single force of 50N acting at 37° above the horizontal. The 50N force at 37° is the sum of the original forces. This is the **resultant vector**.

Adding Vectors that are not collinear and not perpendicular:
To add vectors such as 70 m due E to 50 m at 30°S of E, we need to break the vectors into x-y components.

1. Start by drawing a picture. Don't skip this step; it will help you avoid direction errors.
2. Set up an x-y system. Label the positive and negative directions.



3. Use trig to determine the x and y components of the vector. Be sure to take directions into account by using + and –signs.
   a. The 70 meter vector lies along the +x axis. Its x component is its full length, 70m and it has no y component.
   b. The 50 meter vector must be broken into components. Draw the components in the x and y direction to make a right triangle. The original vector is the hypotenuse.
   c. The x component of the 50 m vector can be found using the cosine function in this case. The y component can be found using the sine function Note the negative sign since we are going in the negative y direction.



Cos 30 = x/50, so x = 50 cos30 = 43.3 m

Sin 30 = -y/50, so y = -50 sin30 = -25 m

Note: the x component won't always be cosine. It depends on the angle you use.

4. Make a table to organize your data.
5. Add the x components and the y components.
6. Use the Pythagorean Theorem to determine the resultant vector.

Vector	x	y
70 m	70	0
50 m	43.3	-25
Resultant	113.3	-25

$$\sqrt{(113.3^2 + 25^2)} = 116\ m$$

7. Use the inverse tan function to find the angle.

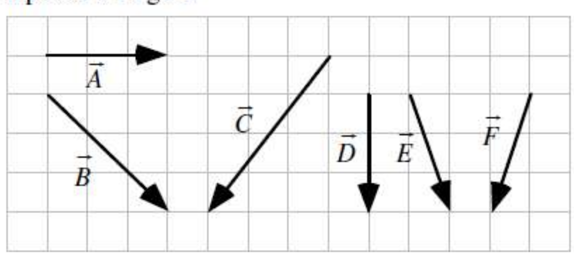
$$\theta = tan^{-1}\ (\tfrac{25}{113.3})\ = 12.4°$$

Practice: Solve the following.

1. Add these vectors:
   15 m/s N
   20 m/s S
   40 m E
   60 m N

2. 28 m N
   15 m S

Shown below are vectors superimposed on a grid.



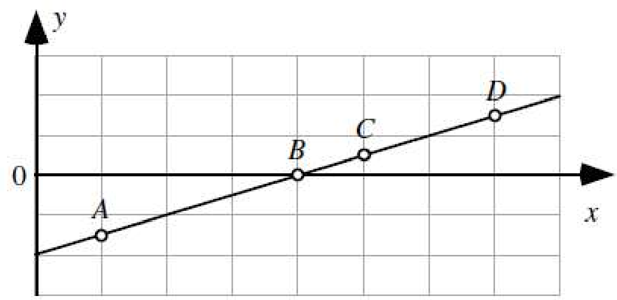
(a) Rank the magnitudes of the x-components of each vector.

						OR			
1 Greatest	2	3	4	5	6 Least		All the same	All zero	Cannot determine

Explain your reasoning.

Part III: Graphing

Four points are labeled on a line.

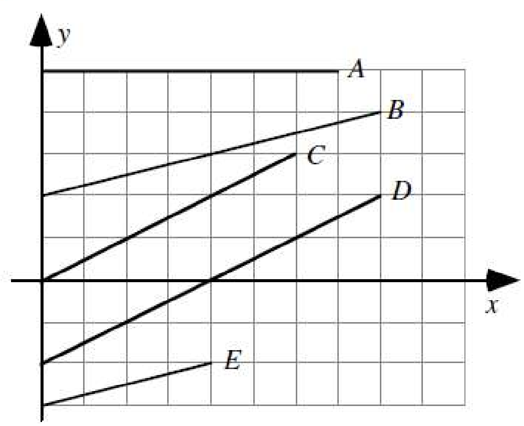


Rank the magnitudes (sizes) of the slopes of the line at the labeled points.

				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

Shown are several lines on a graph.

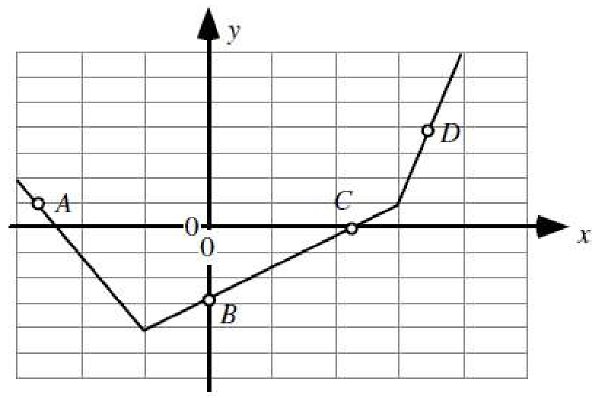


Rank the slopes of the lines in this graph.

					OR			
1 Greatest	2	3	4	5 Least		All the same	All zero	Cannot determine

Explain your reasoning.

Four points are labeled on a graph.



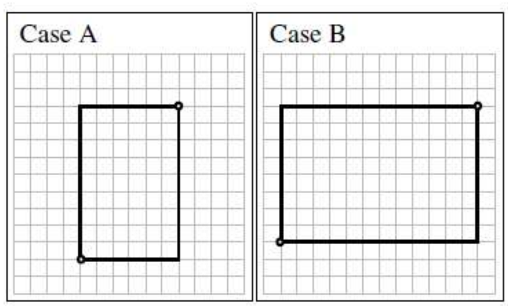
Rank the magnitudes (sizes) of the slopes of the graph at the labeled points.

				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

In each case, a rectangle is drawn on a grid. A student makes the following statement in comparing the slopes of the diagonal lines connecting the corners marked by dots:

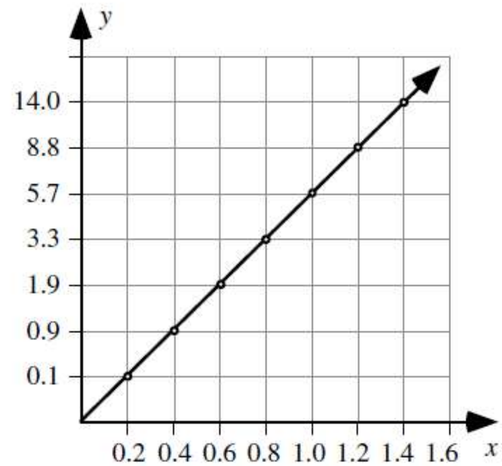
> "The steepness of a line depends on how much the line rises compared to its run. For Case A the rise is 9, and the run is 6, and the difference between rise and run is 3. For Case B, the rise is 8 and the run is 12 and the difference is minus 4. Case B has a smaller slope than Case A, and in Case B the slope is negative."



What, if anything, is wrong with this student's statement? If something is wrong, identify and explain how to correct all errors. If this statement is correct, explain why.

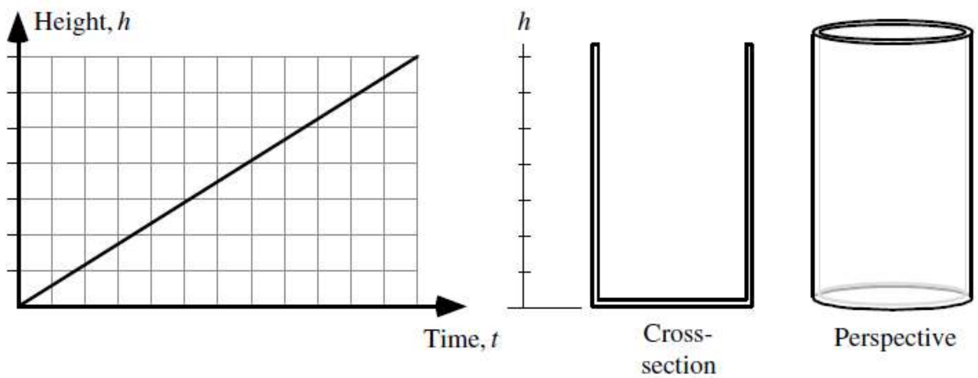
A student uses data from a table to make a graph as shown.

x	y
0.2	0.1
0.4	0.9
0.6	1.9
0.8	3.3
1.0	5.7
1.2	8.8
1.4	14.0



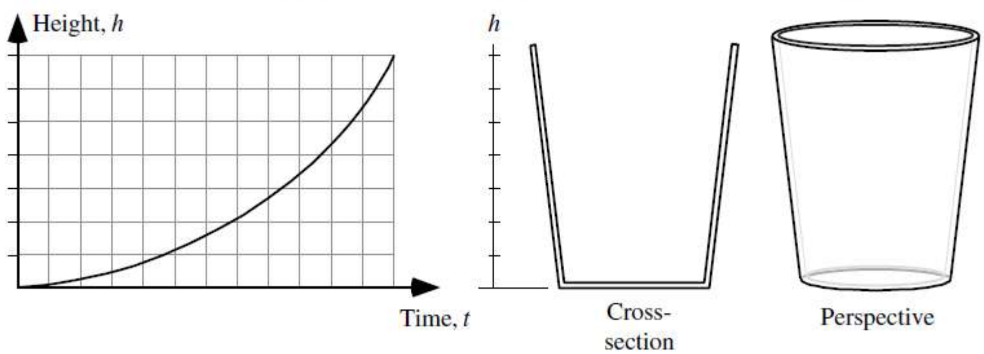
What, if anything, is wrong with this graph? If something is wrong, identify and explain how to correct all errors. If this statement is correct, explain why.

A cylindrical glass is filled using a tap with a constant flow rate of 4 ml per second. A student graphs the height of the water in the glass as a function of time as shown:



What, if anything, is wrong with this graph? If something is wrong, identify and explain how to correct all errors. If this is correct, explain why.

A glass is tapered so that it is wider at the top than at the bottom. The glass is filled using a tap with a constant flow rate of 4 ml per second. A student graphs the height of the water in the glass as a function of time as shown:

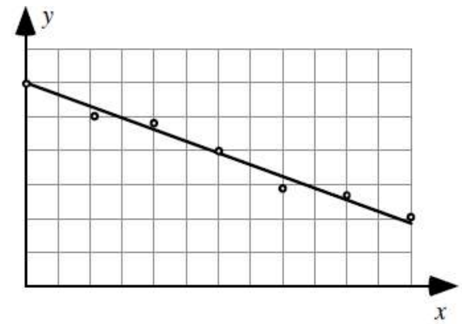


What, if anything, is wrong with this graph? If something is wrong, identify and explain how to correct all errors. If this is correct, explain why.

A student makes the following claim about some data that he and his lab partners have collected:

"Our data show that the value of y decreases as x increases. We found that y *is inversely proportional to* x.*"*

What, if anything, is wrong with this statement? If something is wrong, identify and explain how to correct all errors. If this statement is correct, explain why.



A. $y = 2x$

B. $y = 3x$

C. $y = 2x + 7$

D. $y = -4x$

E. $y = x^2$

Which, if any, of these equations is consistent with the statement *"If* x *doubles, then* y *also doubles?"*

Explain your reasoning.