

2019-20 Northwood High School

AP Physics 1 – Welcome Letter

Dear AP Physics 1 students,

AP stands for “Advanced Placement”. What that means is that the physics class you will take next year will be the equivalent of a college physics class. Physics is the most fundamental science class; it’s the basis of all other. As a result, we often encounter ideas and concepts that are best expressed mathematically. We also rely on empirical evidence (aka “data”), which is best expressed mathematically. For these reasons and others, you will need some math skills. These are all math skills that you have already been taught in Algebra I, Geometry, and in Algebra II. The thing is that you may not be proficient at them and you may not have used them in the context that we use them in physics. That’s why you have a short review assignment to complete before your first day of AP Physics next year. Doing this over the summer will allow us to spend more time on learning physics in class, which will increase your level of success.

The following skills are needed in order to be successful in AP Physics:

1. Graphing data and extracting meaning from it
2. Solving an equation for a needed variable
3. Substituting numbers and expressions
4. Basic right angle trigonometry

If any of these seem completely foreign to you, don’t despair. A video lesson on each of these skills can be found on a youtube playlist, so they should work on any device. I would recommend you watch them all; don’t assume you know everything you need to know.

Link here: <https://goo.gl/zvRol6>

Then complete each of the four assignments. I recommend you complete them in the order that they appear. All four assignments will probably take you around eight hours of time. Don’t wait until the first day of school!

You will turn these four assignments in on the second day of class. On that day, you will take a short assessment (“quiz”) on these four skills. If you miss any questions, then you will have time to study before taking another quiz, which will count as your first quiz grade. If you get all of the questions correct (100%), then you will get a 100 and don’t have to take the second one. If you miss more than one for any particular skill, you will receive a short booster assignment that you will have to complete. The idea is that if you take the time to polish these skills before the third day of class, you will have a lighter homework load, but if you need extra time and help to get to the level you need to be at, then that’s okay too.

Answers to the summer assignment will be posted online so you can check yourself as you’re working. Of course, if all you do is copy the answers you will receive no “credit” for doing it and you’ll probably be frustrated when you “bomb” that first quiz. **Google Classroom Code: jbx5a**

Required Materials for AP Physics: graphing or scientific calculator, pencils, pens, eraser, ruler, graph paper, place to organize notes, place to organize handouts and work.

I will be available on and off throughout the summer, you can reach me at helene_c_mclaughlin@mcpsmd.org, please understand it might take me a few days to respond throughout the summer.

Have fun and good luck!
Mrs. Helene McLaughlin

2019-20 Northwood High School

AP Physics 1 - Summer Assignment

Do not wait until the last minute to start this assignment.

This material will help you with the first couple of weeks in the course!

Things to know about AP Physics:

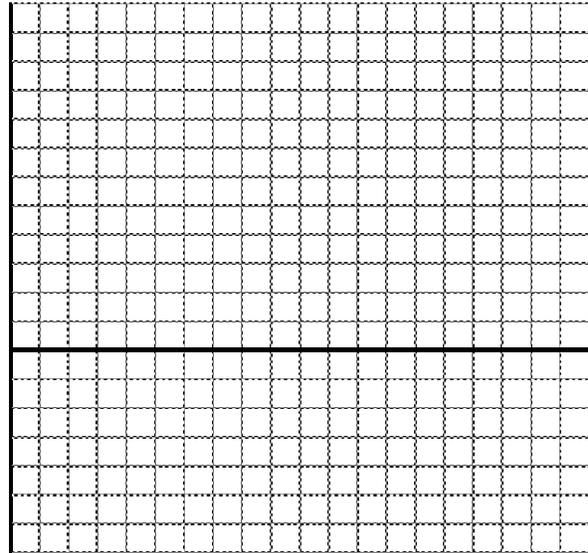
1. Ignore your grade: if you focus on the content, do your work on time with the course pacing, ask questions as often as needed and you will do well.
2. Conceptual knowledge is more important than the math. We will cover concept after concept and to truly do well in the class, you need to be ready to apply that knowledge in a different way as the question being asked will always be different than you expect.
 - a. This means you need to be involved in the course and study regularly. If you do so, you can build upon your knowledge and gain a deeper understanding of the concepts.
3. Your book is your friend. When told to read a chapter or two (or more), you NEED to do it. To say you don't understand it or it does not make sense means you need to read it again (and again and again). Remember to read and understand the words in bold, the diagrams and their captions and review the practice problems done for you as well as the chapter summary.
 - a. When you are in college (which you are now thanks to AP), reading and taking notes are the key to success in the hard sciences.
4. We now live in the technology era. You have THE INTERNET! I am making resources for you as fast as I can and they will always be found in GoogleClassroom or CANVAS but you have THE INTERNET! You will find hundreds of videos teaching you everything and it will be worth it to find good sites and bookmark them.
5. If you are spending an exceptionally large amount of time on one problem, skip it. You will realize that the answer will come to you later when you take a break and refer back to #1.
6. Your lab partner needs to be your guiding light. Rely on one another so that you can help each other when the time comes and use your time wisely (i.e. socializing during class means you will be doing work for class when you want to socialize outside of class).
7. Do not cram. If the course was primarily a memorization-based content, then you could most likely get away with this but unfortunately AP Physics is completely application-based. Therefore, after cramming for eight hours on a certain scientific law and sample problems and you are certain you will do well, the test will have questions asked in a way you have never seen before and now you do not know what to do. First, refer back to #1 again and learn that you have to understand the concepts well enough that you can apply it when you are asked any type of questions by myself or AP Collegeboard.

Part 1a: Graphing Data: Linear Data

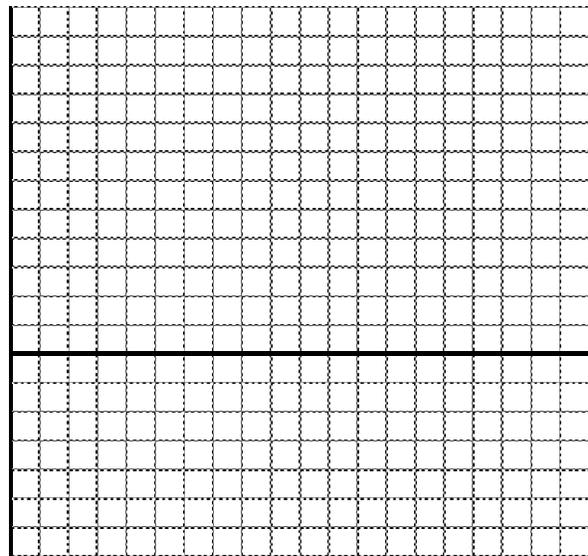
<https://bit.ly/2Ktbnzj>

Graph each of the following sets of data (on separate graph paper if you choose), choosing a reasonable scale and correctly labeling each axis. Draw a best fit line and then find the slope. Write an equation to describe the line, including units.

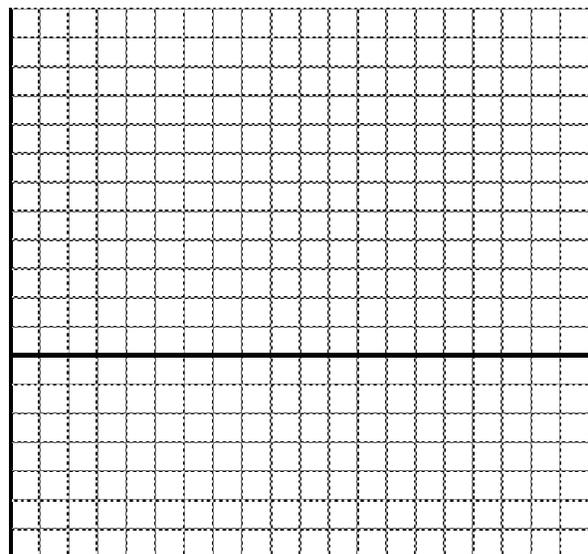
x (m)	t (s)
-7.0	0
-3.2	2
0.9	4
5.1	6
8.8	8
12.7	10
17.2	12



a (m/s^2)	F (N)
1.2	103
1.4	118
1.6	124
1.8	135
2.0	147
2.2	154
2.4	166



ΔV (V)	I (A)
8	0.04
10	0.08
12	0.12
14	0.16
16	0.20
18	0.24
20	0.28



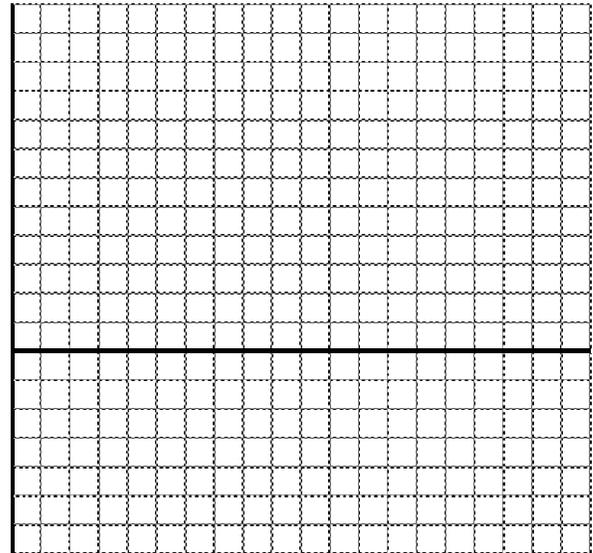
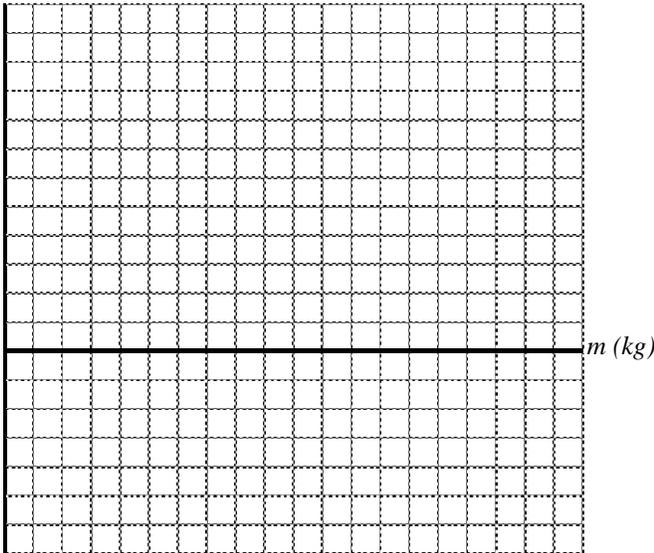
Part 1b: Graphing Data: Non-Linear Data

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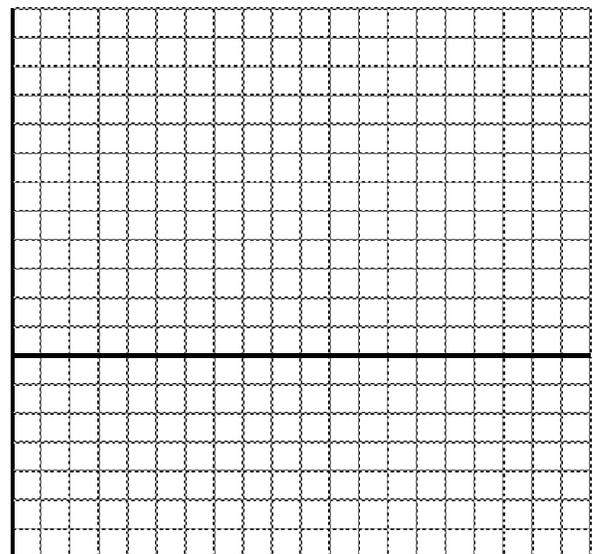
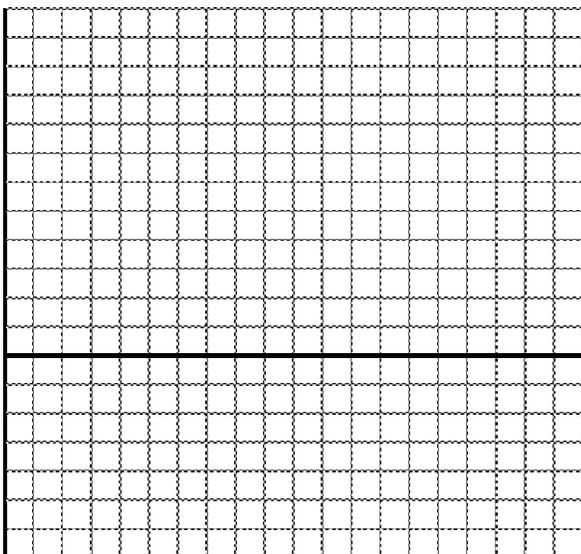
Plot each set of data and identify the relationship between the variables. Write a proportionality between the two variables. Then replot the data so that you get a straight line. Use the empty rows in the table to calculate new values. Draw a best fit line, find the slope, and then write an equation for the line.

a (m/s^2)	4	2	1.4	1	0.8
m (kg)	5	10	15	20	25

a
(m/s^2)



x (m)	-12	12	52	108	180
t (s)	2	4	6	8	10



Part 2: Substitution:

<https://bit.ly/2IkVNTT>

For each of the following, substitute the indicated values and evaluate. Include the units in each step of your work and the answer.

1. $t = \sqrt{\frac{2y}{a}}$ (y = 800 m; a = 4 m/s²)

3. $T = 2\pi\sqrt{\frac{l}{g}}$ (l = 2.0 m; g = 10 m/s²)

5. $P = \frac{V^2}{R_1 + R_2}$
(V = 200 V; R₁ = 80 Ω; R₂ = 20 Ω)

7. $y = y_0 + v_0t + \frac{1}{2}at^2$
(y₀ = -4 m; v₀ = -5 m/s; a = 6 m/s²; t = 4 s)

9. $T = mg - ma - \mu mg$
(m = 5 kg, g = 10 m/s², a = -4 m/s², μ = 0.4)

2. $K = \frac{1}{2}mv^2$ (m = 4 x 10³ kg; v = 2 x 10⁵ m/s)

4. $F = m_1 \left(a_1 - \left(\frac{m_2}{F_g} + a_2 \right) 4 \right)$
(m₁ = 4 kg; m₂ = 5 kg; a₁ = 7 m/s²; a₂ = 2.5 m/s²; F_g = 5 kg·m/s²)

6. $\mu = \frac{m_1g + m_2g}{(m_1 + m_2)a}$
(m₁ = 2 kg; m₂ = 4 kg; g = 10 m/s²; a = 5 m/s²)

8. $a = \frac{m_1g}{m_2} - \frac{m_2g}{m_1}$
(m₁ = 5 kg, m₂ = 4 kg, m₃ = 12 kg; g = 10 m/s²)

10. $F_e = \frac{Kq_aq_b}{r^2}$
(K = 9 x 10⁹ N·m²/C²; q_a = 3 x 10⁻⁶ C; q_b = 3 x 10⁻⁵ C; r = 3 m)

Part 3: Solving Equations

<https://bit.ly/31b6mRV>

Solve each equation symbolically for the indicated variable. **Show all of your work.**

1. $v = \frac{\Delta x}{\Delta t}$ (solve for Δt)

2. $y = y_0 + v_0 t + \frac{1}{2} a t^2$ (solve for a)

3. $F = ma$ (solve for a)

4. $F \Delta t = mv$ (solve for v)

5. $F_s = T - mg$ (solve for m)

6. $P = \frac{v^2}{R}$ (solve for R)

7. $K = \frac{1}{2} m v^2$ (solve for v)

8. $a_{cp} = \frac{v^2}{r}$ (solve for v)

9. $f = \frac{1}{T}$ (solve for T)

10. $T = 2\pi \sqrt{\frac{l}{g}}$ (solve for l)

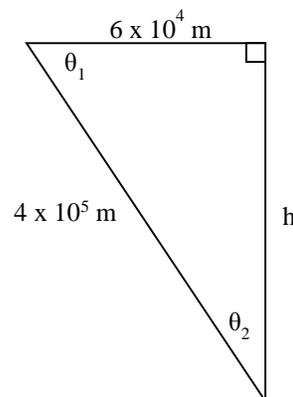
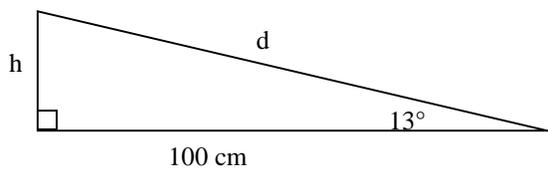
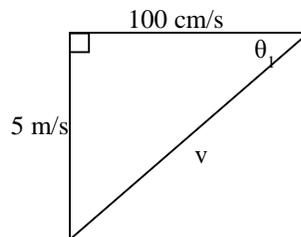
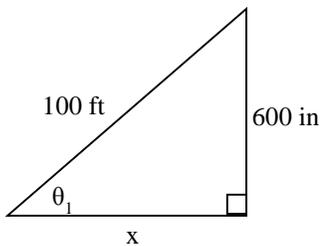
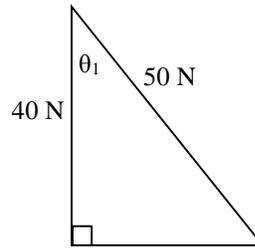
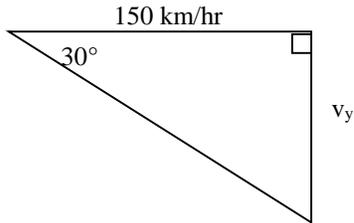
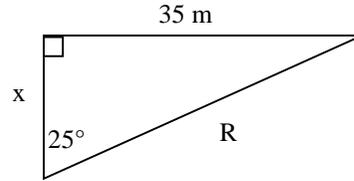
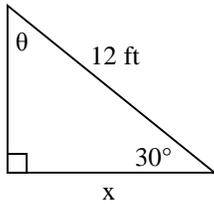
11. $v^2 = v_0^2 + 2a(d - d_0)$ (solve for v_0)

12. $F_e = \frac{Kq_a q_b}{r^2}$ (solve for r)

Part 4: Right Triangle Trigonometry

<https://bit.ly/2wDQsBC>

For each of the given right triangles, solve for all of the indicated quantities. Make sure your calculator is in degree mode. Be sure to include the correct units.



Ungraded Section: The following two sections are important to understanding the first unit in AP Physics 1. Work your way through this section AFTER you have completed the parts above.

Scalar and Vector Quantities

Measurements of quantities in physics will either be scalar or a vector.

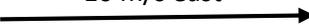
Scalar quantities are measurements that are described by only a magnitude, number only (e.g. 30 m/s, 25 kg, 5 s, etc.)

Scalar is usually said to always be positive but it can have a negative sign in front of it. This means that the scalar quantity is being removed from the system

Examples:

- Time (measured in seconds)
- Mass (measured in kilograms)
- Distance/Length (measured in meters)
- Speed (measured in meters per second, m/s)

Vectors are measurements that have a magnitude and a direction (e.g. 2 m/s east, 9.8 m/s² down, 3 N out, etc.)

Length of vectors are proportional to their magnitude: 5 m/s east  10 m/s east 

Examples:

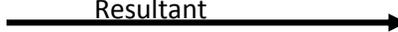
- Displacement (measured in meters)
 - Velocity (measured in meters per second, m/s)
 - Acceleration (measured in meters per second per second, m/s²)
 - Force (measured in Newtons, N)
 - Momentum (measured in kilograms meters per second, kgm/s)
- Vectors can be positive or negative at any time.
 - The negative is not a value less than zero as it is in math but an identification of the direction it is traveling.
 - You have a positive direction and a negative direction, which is the exact opposite of the positive.

\overrightarrow{A}  $\overleftarrow{-A}$  Negative vectors have same magnitude but are 180° opposite direction

Vectors can be moved to any location as long as direction and magnitude are not altered.

Vector Math:

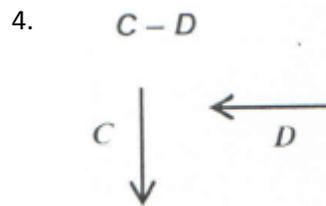
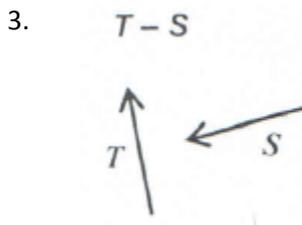
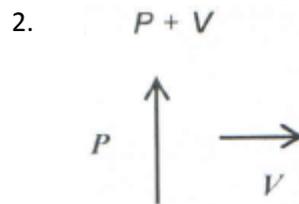
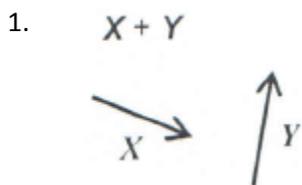
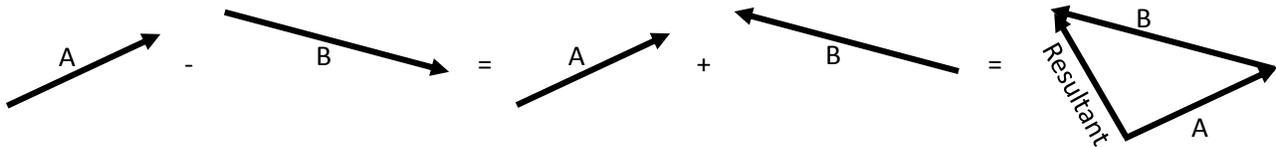
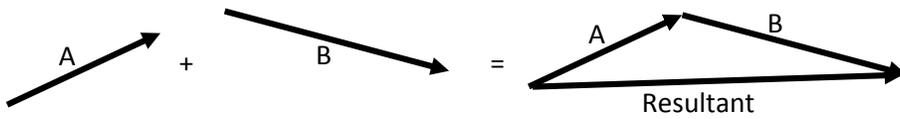
- You can add or subtract vectors but you can always use addition but sometimes with a negative number (subtraction).
 - **Resultant:** The result of adding vectors
 - When adding vectors, there are two methods: tip-to-tail and mathematical components.

\overrightarrow{A}  + \overrightarrow{B}  = $\overrightarrow{\text{Resultant}}$ 

\overrightarrow{A}  - \overrightarrow{B}  = \overrightarrow{A}  + $\overleftarrow{-B}$  = $\overrightarrow{\text{Resultant}}$ 

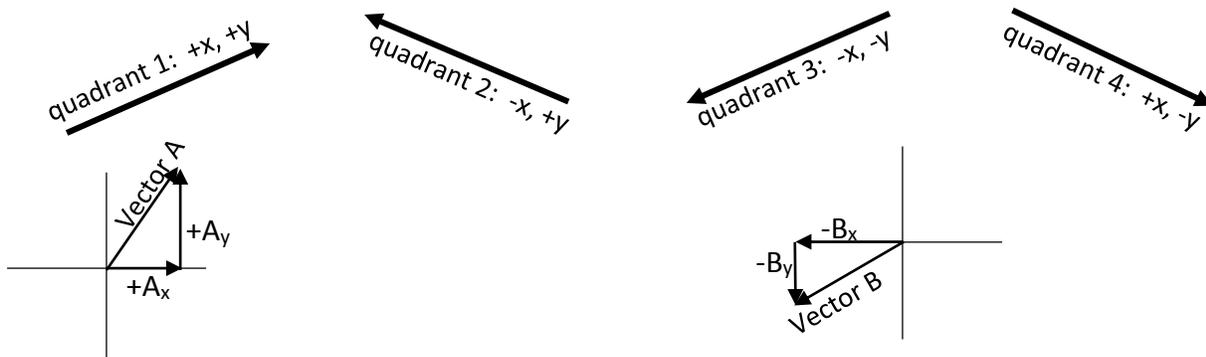
Vector Math Cont.

This tip-to-tail method can also be done in two-dimensions

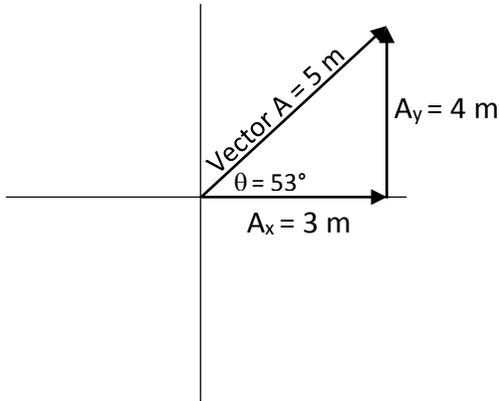


The above examples demonstrated the tip-to-tail method where you can move vectors around as long as the tip of one vector touches the tail (back end) of the next vector. The resultant will start at the tail end of the first vector and move in a straight path to the tip of the last vector. It is the only vector in the diagram that is not tip-to-tail.

In the mathematical component method, we do not connect or move any vector around the paper. We simply use the coordinate plane orientation with the four quadrants and use basic trigonometry to find the horizontal and vertical components that make up the vector (we take the vector as the hypotenuse and make a right triangle).



Vector Math Cont.



Vector A has a magnitude of 5 m and a direction of 53° above the x-axis

Using trigonometry, you can find the sides and the missing angles

\therefore (means therefore) the horizontal x-component is 3 m and the vertical component is 4 m. Pythagorean theory is essential!

You try it now with the following problems:

Find the magnitude of the x- and y-components for the three vectors (some will be negative or zero)

5. Vector 1

x-component:

y-component:

6. Vector 2

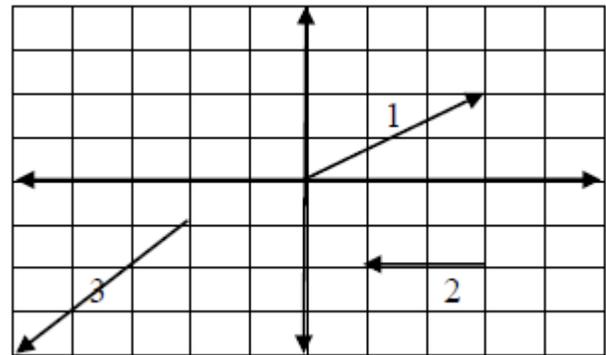
x-component:

y-component:

7. Vector 3

x-component:

y-component:



Given a vector (magnitude and direction), you should now be able to graph it on a coordinate plane and using trigonometry find the x- and y-components. Remember to keep your calculator in Degree Mode (i.e. not Radians).

Take the following vectors, draw it on a coordinate plane and calculate the components:

8. 15 m @ 77°

Quad 2 ($91-179^\circ$)

Quad 1 ($0-89^\circ$)

9. 8.0 m @ 235°

10. 11 m @ -45° (think about it – negative)

Quad 3 ($181-269^\circ$)

Quad 4 ($271-359^\circ$)

Vector Math Cont.

Now work backwards! Take these components and find the vector's magnitude and direction.

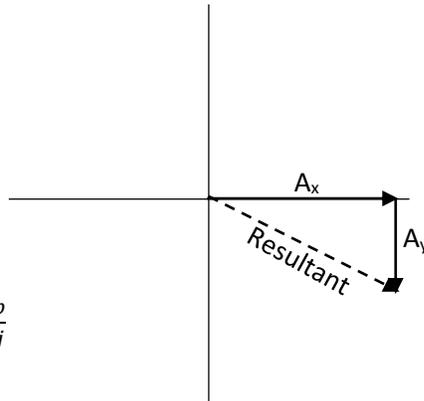
e.g. $A_x = 10 \text{ m}$, $A_y = -5.0 \text{ m}$

$$\sqrt{A_x^2 + A_y^2} = \text{Resultant}$$

$$\sqrt{10^2 + (-5)^2} = 11 \text{ m}$$

$$\tan \theta = \frac{\text{opp}}{\text{adj}} \therefore \theta = \tan^{-1} \frac{\text{opp}}{\text{adj}}$$

$$\tan^{-1} \frac{-5.0}{10} = -27^\circ \text{ or } 333^\circ$$



Resultant is 11 m @ 333°

11. $x = 200, y = 100$

12. $x = -100, y = 75$

13. $x = -25, y = -45$

14. $x = 30, y = -60$

Ungraded Section: The following section are important to understanding the first unit KINEMATICS in AP Physics 1. Work your way through this section AFTER you have completed the parts above.

Kinematics (science of motion), Labs & Simulations

There will be times throughout the year when you will be required to go online to complete online simulation labs as well as research topics being discussed in the class. Here is your first! One of the best resources for basic physics understanding and application is www.physicsclassroom.com, so be sure to bookmark it for future reference (Hyperphysics is another).

You will use this website to complete the following questions and graphs, which will give you the foundation needed for not only the first unit of study (Kinematics), but for the whole course as it is cumulative!

Go to www.physicsclassroom.com

Click on the link on the left for "Physics Tutorial"

In the middle under "The Physics Classroom Topics" choose the link "1-D Kinematics"

Take your time, record some notes for yourself and slowly read over all the material found in lesson 1 through lesson 6.

Answer and complete the following:

Lesson 1

1. Describe in your own words the meaning of a vector's magnitude.
2. Differentiate between displacement and distance and include the following: when are they ever the same and when are they different?
3. Do the same as above for question 50 but for speed and velocity.
4. How does acceleration relate to velocity and give an example of when one would experience a negative acceleration?

Kinematics (science of motion), Labs & Simulations Cont.

Lesson 2

5. Draw an example of a ticker-tape diagram for an automobile accelerating from rest and moving to the right.

6. Draw a vector diagram for the same thing as 53.

Lesson 3 & 4

7. Sketch a position versus time (position-time or x-t) graph and a velocity versus time (v-t) graph for each of the following scenarios (assume right is positive for both displacement and velocity):
 - a. A car moving to the right at a constant velocity



- b. A car moving to the right with an increasing velocity



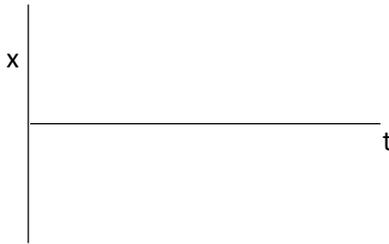
- c. A car moving to the right with a decreasing velocity



Kinematics (science of motion), Labs & Simulations Cont.

Lesson 5

8. What is the symbol for gravity and what value does it represent (memorize both for the whole year!)?
9. What is the total field gravitational value for “Jacksonville”? Use the widget at the bottom of the page.
10. Explain the term “free fall” in your own words.
11. Draw the curves for both x-t and v-t graphs below for an object in free fall assuming up is positive (the object would be dropping *down* toward the surface of Earth).



12. What value would the acceleration on the object above have now? Does it change anytime during its fall? Describe the motion of its fall.
13. If there was no air resistance, which object falls faster: an unfolded piece of paper or an anvil?

Lesson 6

Although physicsclassroom.com writes them differently, these are the first four kinematic equations and the first four equations you will learn/use throughout the whole year (cumulative remember that!):

$$v = \frac{\Delta x}{\Delta t} \quad v_f = v_i + at \quad v_f^2 = v_i^2 + 2a(\Delta x) \quad x_f = x_i + v_i t + \frac{1}{2} at^2$$

These equations are used often and can have their x-displacements switched with y-displacements for vertical motion.

14. Which one would be best to find the distance the object fell from free-fall if it fell for six seconds, assuming it fell in the absence of air resistance and it still hasn't hit the ground? Solve this problem and show all steps of work (you will need to replace the variables x with y as the object is moving only on the y-axis).