Name: _____ Date: _____ Period: _____

AP Physics 1 - Summer Assignment
2019-20 Richard Montgomery High School

Welcome to AP Physics 1! AP Physics 1 is an algebra-based, introductory **college-level** physics course. Students cultivate their understanding of physics through inquiry-based investigations as they explore these topics: kinematics; dynamics; circular motion and gravitation; energy; momentum; simple harmonic motion; torque and rotational motion; electric charge and electric force; DC circuits; and mechanical waves and sound.

While AP Physics 1 is Algebra based, it does not mean that the course is easy. There is a lot of analytical reasoning and application of mathematical practices. The course is not about solving problems, although there will be a lot of problem solving. It is about understanding the underlying laws of physics that pertain to everyday situations, and then applying those laws to predict what will happens in new situations. In addition, the course is a laboratory based course where students will graphically analyze data that they collect. In order for students to be able to focus on the physics principles being studied, *they need to be comfortable with many mathematical skills learned previously*. Completing this packet will help you review some key skills and identify topics that you need to brush up more on prior to the start of class.

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

This assignment is due the second day of school (9/4/2019) and will be graded in the homework category. On that day, you will take a short 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 in the formative category. 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 before taking another quiz.

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 Complete all four main assignments in the order that they appear. All four assignments will probably take you around eight hours of time. **Do not wait until the last minute to start this assignment!** After completing the four math assignments, continue work to finish the rest of the packet. Vector addition and kinematics are the very first unit and it will go by quickly. Completing the summer packet preview will help you no be overwhelmed the first few weeks.

You must show all your work in all steps. Use additional paper as needed. Please note if insufficient work is shown because it was all done on your calculator, your calculator will be credited with half the points for the summer assignment.

Reviewing this material will help you especially with the first quarter in the course!

Resources for review or preview of course content:

http://www.physicsclassroom.com/	Tutorial covers at a basic level most AP Physics 1 topics.
http://phet.colorado.edu/	Physics and math simulations.
http://khanacademy.org/	Math practice from K through Calculus.

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, take advantage of all relearning opportunities, and ask questions as often as needed, 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. Content goes by quickly, but is built upon all year. At the end of the course, it all comes together.

> → 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.

> → 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! The teacher will provide resources in 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 that work for YOU, 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.

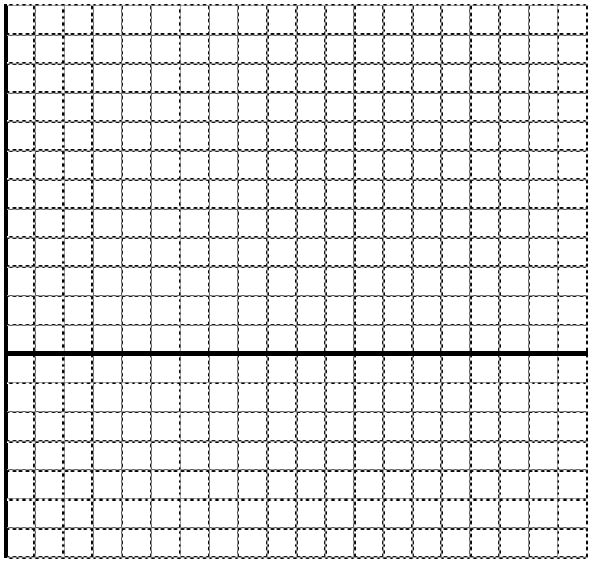
6. Your lab partners need to be your guiding light. Rely on one another so that you can help each other when the time comes and use your time wisely (i.e. socializing during class means you will be doing work for class when you want to socialize outside of class).

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 question in class or by the AP College Board.

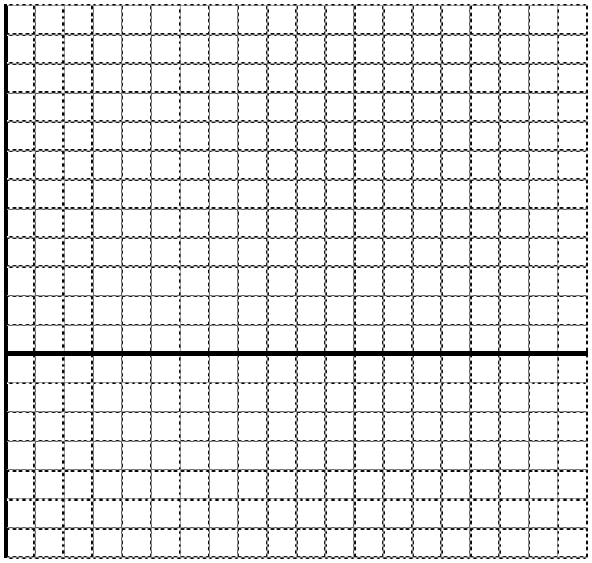
Part 1a: Graphing Data: Linear Data
https://bit.ly/2Ktbnzj

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.

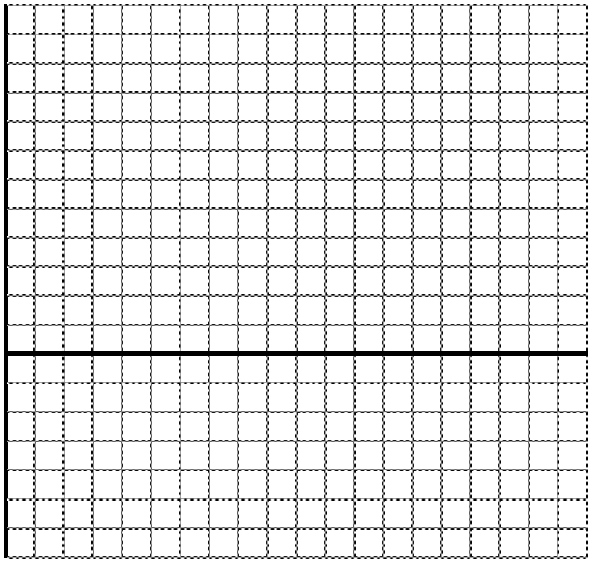
x (m)	*t (s)*
-7.0	0
-3.2	2
0.9	4
5.1	6
8.8	8
12.7	10
17.2	12



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

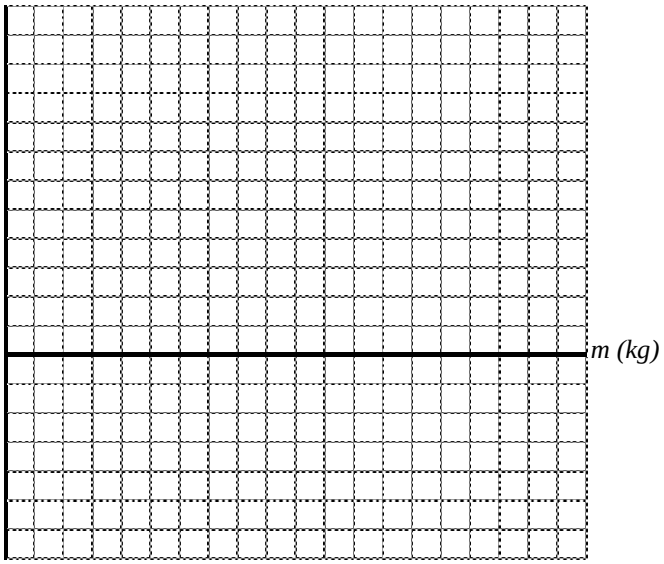


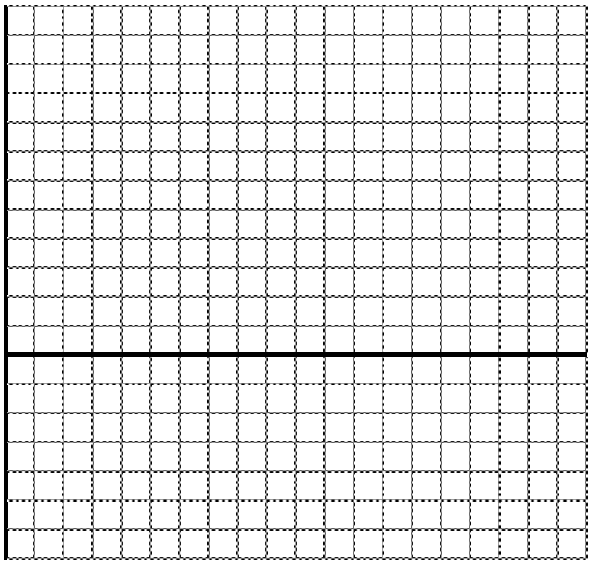
Part 1b: Graphing Data: Non-Linear Data
https://bit.ly/2Z6i3Yj

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)





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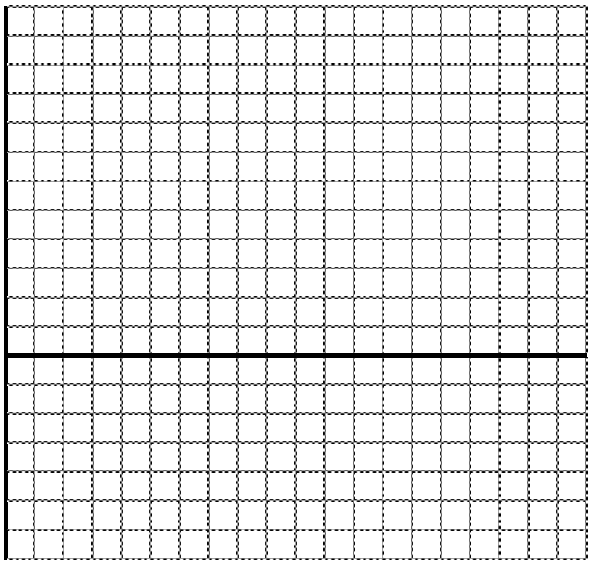
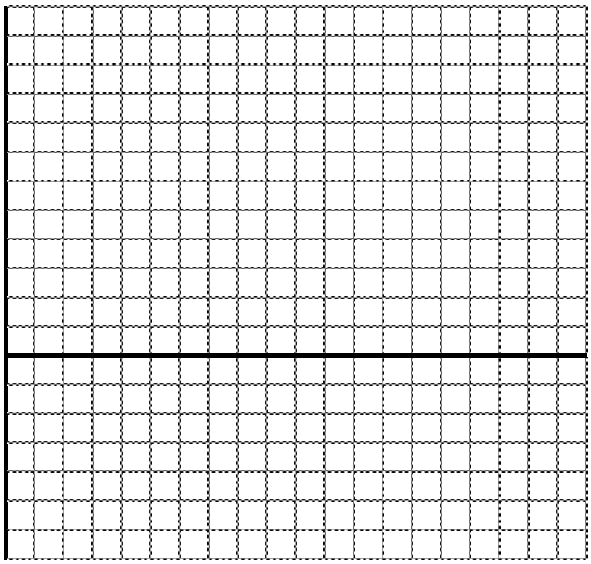
x (m)	-12	12	52	108	180
t (s)	2	4	6	8	10





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/s^2)

2. $K = \frac{1}{2}mv^2$ (m = 4 x 10^3 kg; v = 2 x 10^5 m/s)

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

4. $F = m_1\left(a_1 - \left(\frac{m_2}{F_g} + a_2\right)4\right)$

(m_1 = 4 kg; m_2 = 5 kg; a_1 = 7 m/s^2; a_2 = 2.5 m/s^2; F_g = 5 kg·m/s^2)

5. $P = \frac{V^2}{R_1+R_2}$

(V = 200 V; R_1 = 80 Ω; R_2 = 20 Ω

6. $\mu = \frac{m_1g+m_2g}{(m_1+m_2)a}$

(m_1 = 2 kg; m_2 = 4 kg; g = 10 m/s^2; a = 5 m/s^2

7. $y = y_0 + v_0t + \frac{1}{2}at^2$

(y_0 = -4 m; v_o = -5 m/s; a = 6 m/s^2; t = 4 s)

8. $a = \frac{m_1g}{m_2} - \frac{m_2g}{m_1}$

(m_1 = 5 kg, m_2 = 4 kg, m_3 = 12 kg; g = 10 m/s^2)

9. $T = mg - ma - \mu mg$

(m = 5 kg, g = 10 m/s^2, a = -4 m/s^2, μ = 0.4)

10. $F_e = \frac{Kq_aq_b}{r^2}$

(K = 9 x 10^9 N·m^2/C^2; 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**)

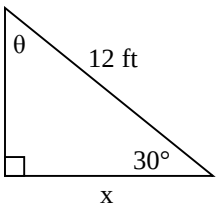
10. $T = 2\pi\sqrt{\frac{l}{g}}$ (solve for **l**)

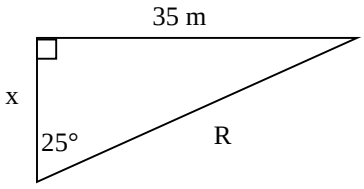
11. $v^2 = v_0^2 + 2a(d - d_0)$ (solve for $\mathbf{v_0}$)

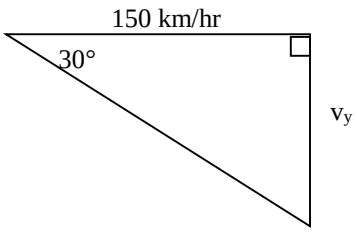
12. $F_e = \frac{K q_a q_b}{r^2}$ (solve for **r**)

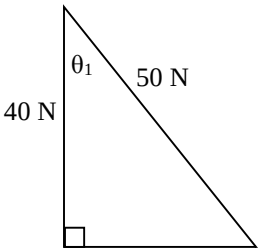
Part 4: Right Triangle Trigonometry
https://bit.ly/2wDQsBC

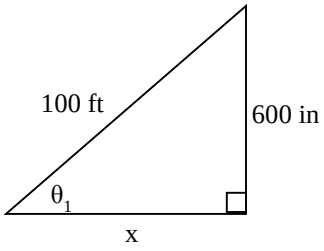
*For each of the given right triangles, **solve for all of the indicated quantities**. Make sure your calculator is in degree mode. Be sure to include the correct units.*

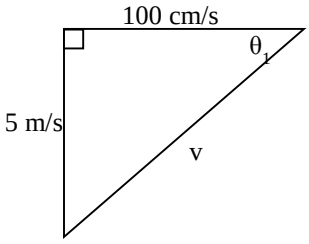


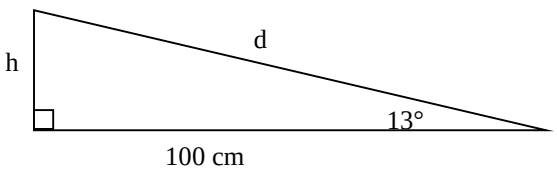


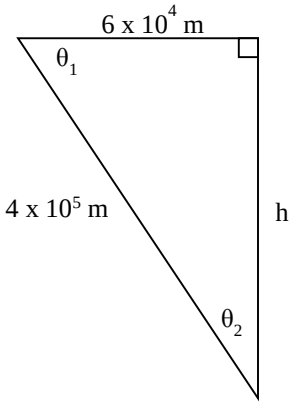












<u>Ungraded Section:</u> The following two sections are important to understanding the first unit in AP Physics 1. Work your way through this section AFTER you have completed the parts above.

<u>Scalar and Vector Quantities</u>

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

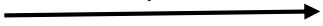
<u>Scalar quantities</u> are measurements that are described by only a magnitude, number only (e.g. 30 m/s, 25 kg, 5 s, etc.)

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)

<u>Vectors</u> are measurements that have a magnitude and a direction (e.g. 2 m/s east, 9.8 m/s^2 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/s^2)
- Force (measured in Newtons, N)
- Momentum (measured in kilograms meters per second, kgm/s)

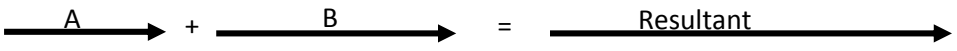
- Vectors can be positive or negative at any time.
- The negative is not a value less than zero as it is in math but an identification of the direction it is traveling.
- You have a positive direction and a negative direction, which is the exact opposite of the positive.

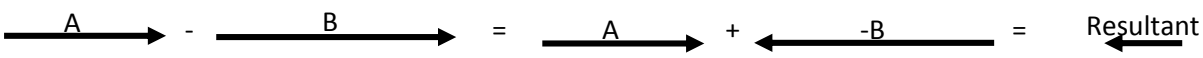
Negative vectors have same magnitude but are 180° opposite direction

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

Vector Math:

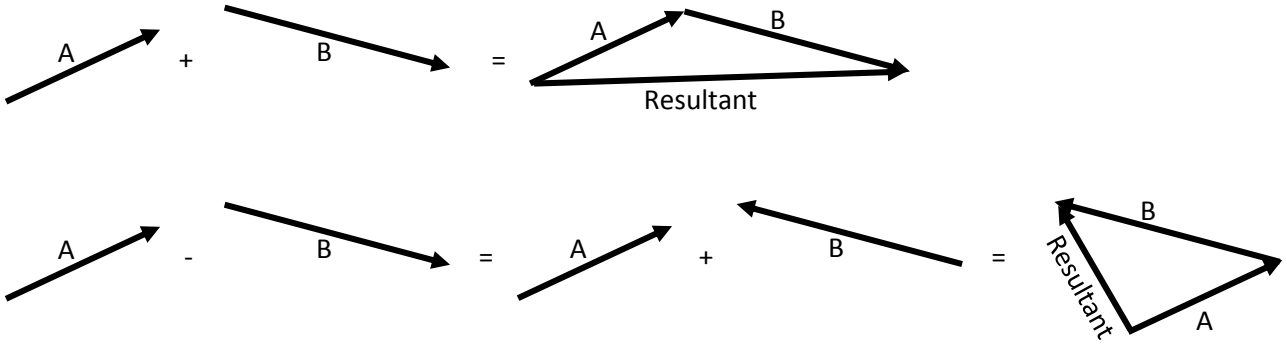
- You can add or subtract vectors but you can always use addition but sometimes with a negative number (subtraction).
  - **<u>Resultant</u>**: The result of adding vectors
    - When adding vectors, there are two methods: *<u>tip-to-tail and mathematical components</u>*.

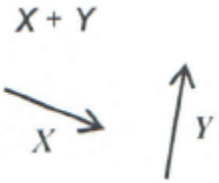


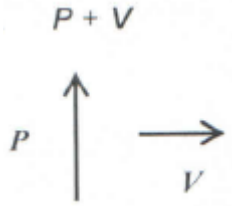


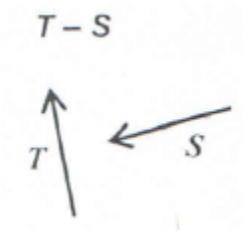
Vector Math Cont.

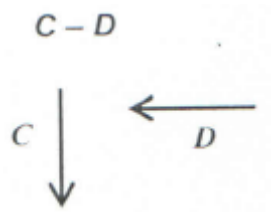
This tip-to-tail method can also be done in two-dimensions



1. 

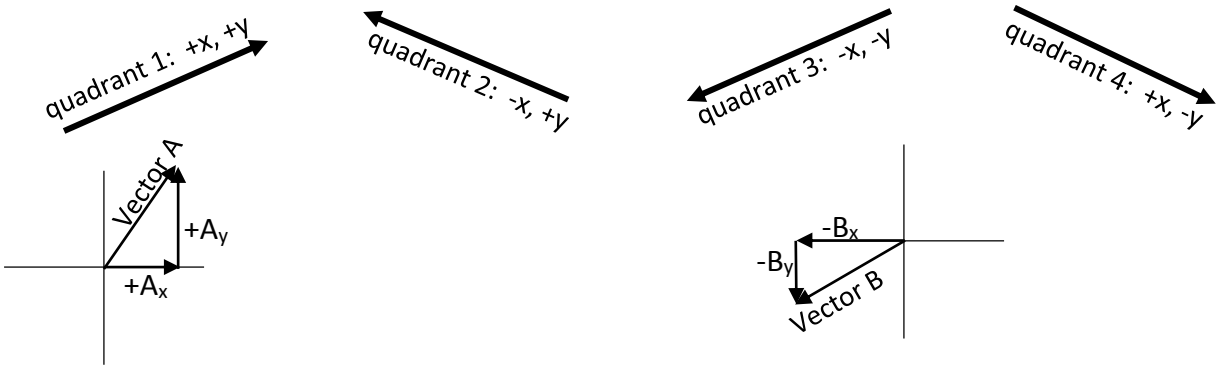
2. 

3. 

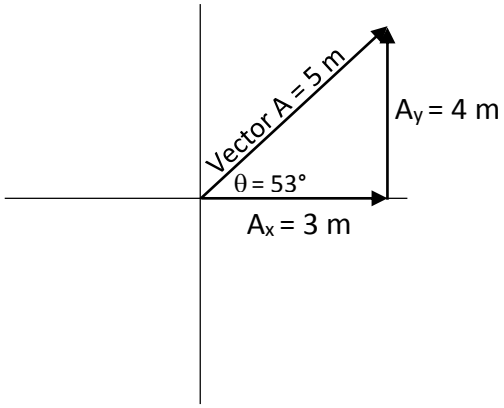
4. 

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

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

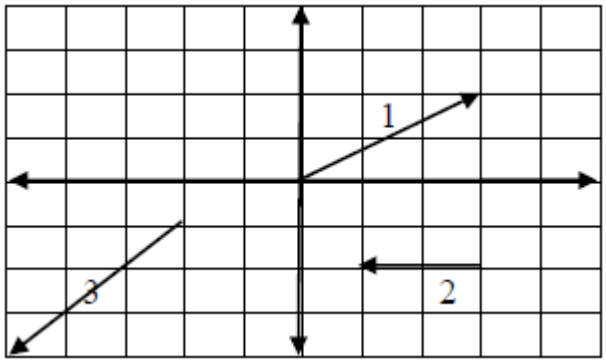
You try it now with the following problems:

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:



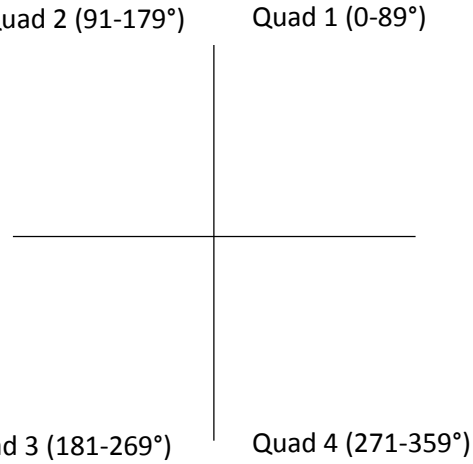
Given a vector (magnitude and direction), you should now be able to graph it on a coordinate plane and using trigonometry find the x- and y-components. Remember to keep your calculator in Degree Mode (i.e. not Radians).

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

8. 15 m @ 77°

9. 8.0 m @ 235°

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



Vector Math Cont.

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

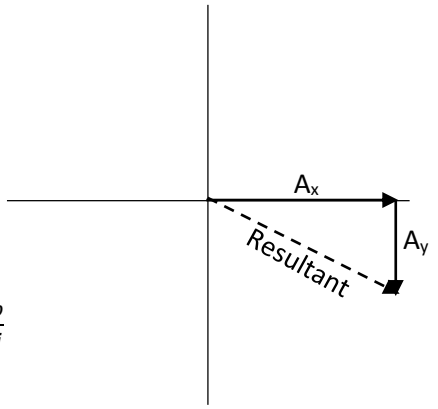
e.g. A_x = 10 m, A_y = -5.0 m

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

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

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

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



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

<u>Ungraded Section:</u> 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.

<u>Kinematics (science of motion), Labs & Simulations</u>

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.

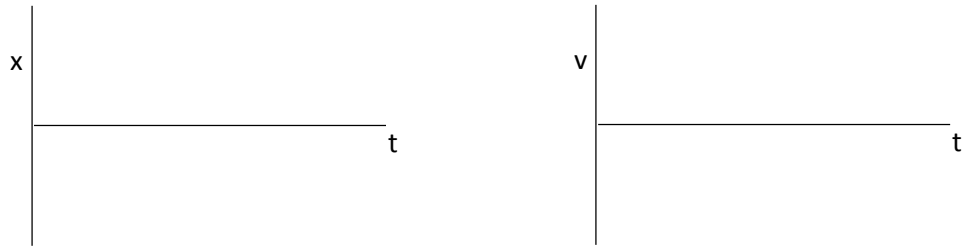
Lesson 2

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

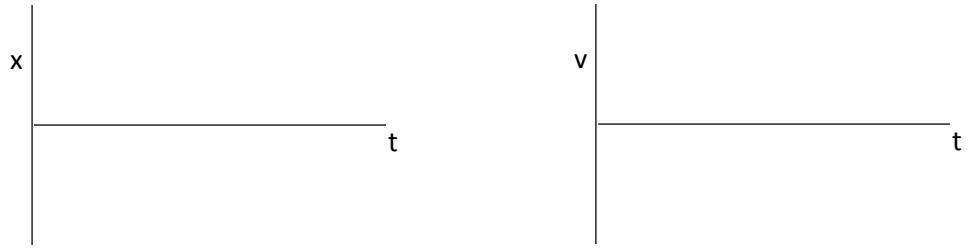
6. Draw a vector diagram for the same thing as 53.

Lesson 3 & 4

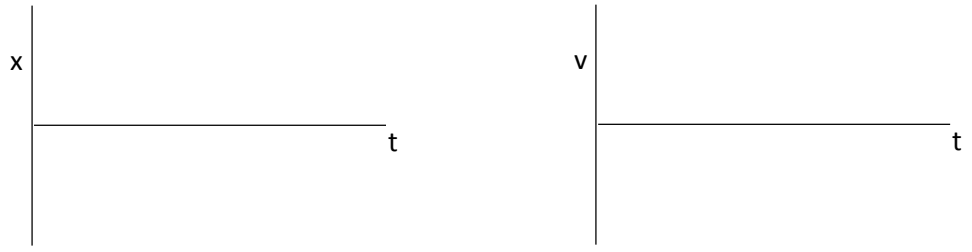
7. Sketch a position versus time (position-time or x-t) graph and a velocity versus time (v-t) graph for each of the following scenarios (assume right is positive for both displacement and velocity):
    a. A car moving to the right at a constant velocity



    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.

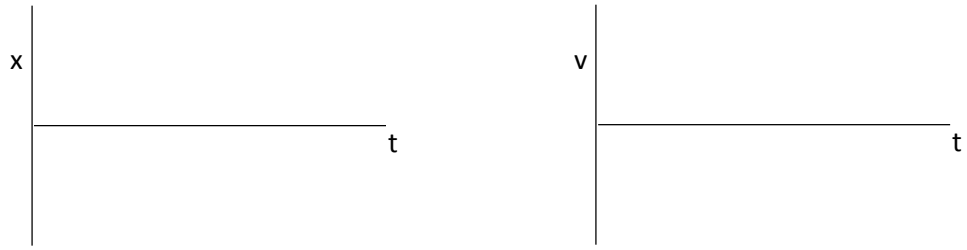
Lesson 5

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!):

$$v = \frac{\Delta x}{\Delta t} \qquad v_f = v_i + at \qquad {v_f}^2 = {v_i}^2 + 2a(\Delta x) \qquad x_f = x_i + v_i t + {}^1\!/_2\, at^2$$

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 it 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).