POSNACK SCHOOL

Summer Assignment AP Physics 1

The concepts of physics are the most fundamental found in the sciences. By the end of the year, you will have had the opportunity to make and test many hypotheses about the behavior of everyday objects and to design and build some interesting contraptions that will demonstrate the laws of mechanics. This course will require a serious commitment and independent work on the part of every student in order to ensure a pace by which we can master the material before the AP testing. This preparation packet should assist all of us in achieving that goal.

1. Go to Khan Academy and find the AP Physics 1 series of videos, specifically the one dimensional motion section(https://www.khanacademy.org/science/physics/one-dimensional-motion). Watch the lessons from the intro to physics through the last part of the acceleration section, and read the associated text pages to become familiar with the terms and concepts involved in one-dimensional motion. The content in Part 1 of this packet is covered in those videos (you won't see the same problems or questions, but the concepts are the same, so you should be able to do the work.) For more help, try some of the supplemental links here.

2. Complete the math and physics review. Show all your work for credit.

All parts of this assignment are to be submitted via Canvas by the end of the first day of school.

The summer assignment is to be one's own work. That does not mean that you cannot help one another when you run into problems, but it DOES mean that copying work is not acceptable and, if discovered, will result in a zero for the assignment.

Part 1:

What is Physics, Vectors and Scalars, etc.

1. What is the difference between a vector and a scalar?

2. Give 3 examples of vectors and 3 examples of scalars.

   Vectors:

Scalars:

3. What is meant by magnitude as it is used to describe physical quantities?

4. Using the scale 1cm = 10 m, draw a vector diagram for each of the following (do not neglect to define your coordinate system in each- meaning, draw a set of axes that clearly indicate direction):
   a. 20 meters south
   b. 45 meters 20° below the x-axis
   c. 17 meters at 140°

5. A bird flies 12 km south, then 5 km east and finally 12 km north.
   a. What is the distance traveled by the bird?

   b. What is the bird's displacement?

1 Dimensional Kinematics- Uniform Motion

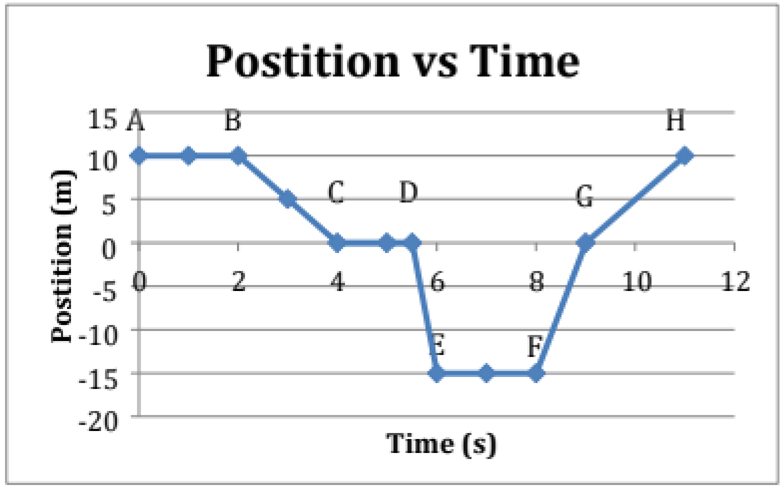
1. Define kinematics:

2. What do each of the following represent?
   a. Δt ________________ b. Δx _________________ c. v ________________

3. Calculate the average velocity, in meters per second, for each of the following:
   a. A train travels 5200 m east in 45 minutes.

b. A giraffe moves from a location 5 meters south of a tree to a location 25 meters north of the tree in 15 minutes.

4. Examine the graph below. It represents the motion of a particle over a period of 12 seconds. Determine the answers to items A through G.



a. Average velocity between points A and B

b. Average velocity between points B and C

c. Average velocity between points G and H

d. Total displacement from time 0 to time 11 s

e. What is the particle doing between points B and C?

f. What is it doing between F and G?

g. When is the particle's speed the greatest?

1 Dimensional Kinematics- Non-uniform (Accelerated)

1. Calculate the average acceleration:
   a. A rocket has a starting velocity of 5 m/s and a velocity of 200 m/s after 40 s.

   b. A train traveling at 40 m/s south changes its velocity to 12 m/s north over a period of 15 s.

2. A runner is initially moving at +2.5 m/s and accelerates at the rate of -0.9 m/s2 for 2 s. What is the velocity of the runner after the 2 s?

3. A car traveling with a velocity of +7 m/s accelerates at +2 m/s2 for 10 s. How far does the car travel in the 10 s?

4. What happens to the speed of a car which, having an initial negative velocity, undergoes a positive acceleration? (Will it increase, decrease, or stay the same?)

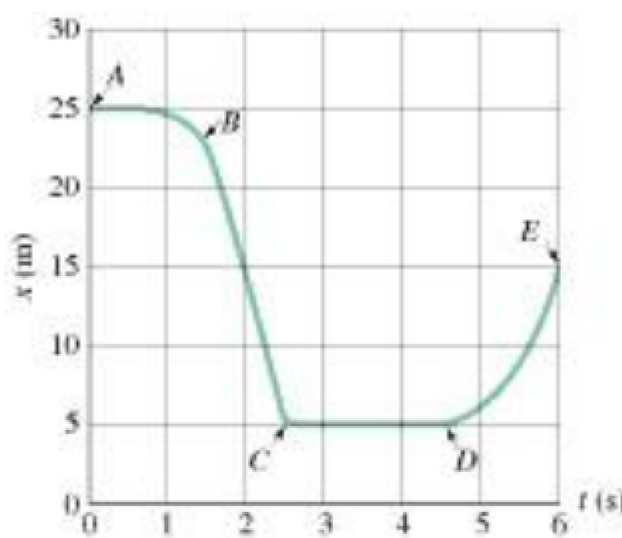
5. Explain why it is that your car has 3 accelerators. What/where are they?

6. Examine the graph below, which represents the motion of a particle over six seconds. (Note that this is a position vs. time graph.)

a. Calculate the average velocity between points A and C.

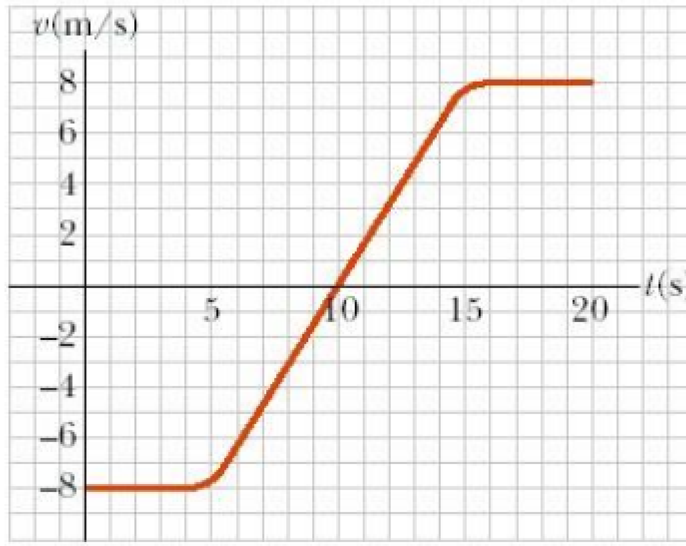
b. How could you calculate the instantaneous velocity at point B?

c. What is the particle doing between t=3s and t=4 s?



d. What does the particle do between 5 s and 6 s? How can you tell?

7. Examine the graph below, which represents the motion of a particle. (Note that this is a velocity vs. time graph.)



a. What is the velocity of the particle between t=0 and 4 s?

b. What is the average acceleration between t=5 s and t= 15 s?

c. What does the particle do at t=10 s?

d. What is the total displacement of the particle (from t=0s to t=20s)? Explain.

Part 2:

Always use the correct number of significant figures in your answers whether it is scientific notation or regular notation.

When dealing with significant figures, remember that all non-zero numbers are considered significant. If there is a decimal in the number, all numbers are significant starting with the first non-zero number and continuing until the end. If there is no decimal, then only non-zero numbers and zeroes in the middle of non-zero numbers are significant.

e.g. 123 – 3 sig figs; 101 – 3 sig figs; 1010 – 3 sig figs; 1010. – 4 sig figs; 0.010 – 2 sig figs; 0.00001 – 1 sig fig 10

Basic Algebra

You will be using these skills daily. Familiarize with these physics equations as you solve them with the correct number of significant figures and correct unit of measurement. (Hint: Whatever you do with the #s, you do with the units!)

1. $K = \frac{1}{2}mv^2$ Answer: _______________ Unit: __________

$K = \frac{1}{2}(210\ kg)(10.5\ m/s)^2 =$

2. $F = G\frac{m_1 m_2}{r^2}$ Answer: _______________ Unit: __________

$F = (6.67 \times 10^{-11} \frac{Nm^2}{kg^2})\frac{(5.64\times10^{24} kg)(1.99\times10^{31} kg)}{(1.51\cdot10^{15} m)^2}$

3. $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$ Answer: _______________ Unit: __________

$\frac{1}{R_p} = \frac{1}{24\Omega} + \frac{1}{18\Omega} =$

4. $\tau = rFsin\theta$ Answer: _______________ Unit: __________

$\tau = 1.4m \cdot 28N \cdot sin47 =$

5. $T = 2\pi\sqrt{\frac{l}{g}}$ Answer: _______________ Unit: __________

$T = 2\pi\sqrt{\frac{0.34m}{9.8m/s^2}} =$

Basic Algebra Cont.

Once again, this will be a daily routine in this class but now you must do it with just variables. So put away your calculator and use your head. Don't get confused with the letters, think of them as numbers and algebraically rearrange for the chosen variable.

6. $U_g = mgh$; solve for h

7. $P = \frac{W}{\Delta t}$; solve for Δt

8. $a_c = \frac{v^2}{r}$; solve for v

9. $qV = \frac{1}{2}mv^2$; solve for v

10. $y_f = y_i + v_i t + \frac{1}{2}at^2$; solve for a

11. $F = k\frac{q_1 q_2}{r^2}$; solve for q_2

12. $R = \rho\frac{1}{a}$; solve for ρ

13. $v_f^2 = v_i^2 + 2(x_f - x_i)$; solve for x_i

14. $n_1 sin\theta_1 = n_2 sin\theta_2$; solve for θ_2

15. $T = 2\pi\sqrt{\frac{m}{k}}$; solve for k

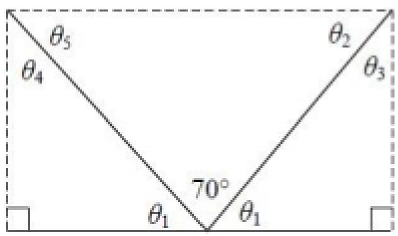
Basic Geometry/Trigonometry

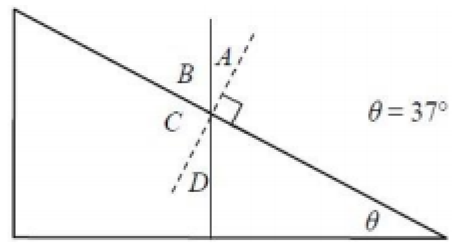
You will use basic geometry (area, perimeter, shapes, angles, etc.) and trigonometry (sin, cos, and tan) often. You will need to know the basic geometry equations for shapes and areas and you will need to know the trig. for common angles without the use of a calculator (see table below).

Solve for the missing angles in the following problems:

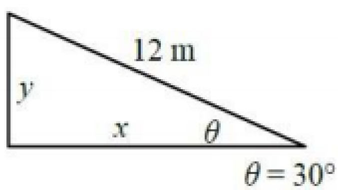
16. Solve for angles 1-5.

17. Solve for angles A-D.





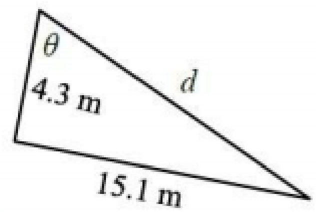
18. Solve for the missing sides:



$y =$ ________

$x =$ ________

19. Solve for missing side and angle:

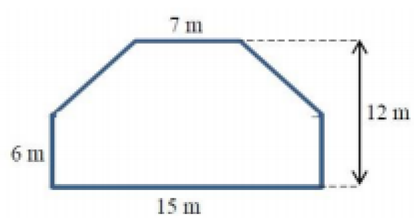


$d =$ _______

$\theta =$ _______

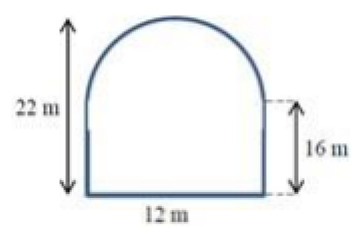
Solve for the area in the following problems:

20.



Area = ________

21.



Area = ________

Complete the following table (learn these values)

Trigonometry Function	**0°**	**30°**	**45°**	**60°**	**90°**
$sin\theta$					
$cos\theta$					
$tan\theta$					

<u>Measurements, Metric, and Converting</u>

Like all science classes, all measurements will be made with the metric system, SI Units. Therefore, you must be absolutely comfortable with the metric prefixes, their magnitude of power compared to the base unit and be able to convert between them quickly.

Complete the following table:

Metric Prefix	Power	Symbol
exa		
peta		
tera		
giga		
mega		
kilo	10^3	k
base unit	10^0	-
centi		
milli		
micro		
nano		
pico	10^{-12}	p
femto		
atto		

Convert the following using dimensional analysis (show your work):

22. 35 kg → g

23. 9 MJ → cJ

Graphing/Data Analysis

You must be able to interpret and create graphs by hand and with computer software (I prefer Logger Pro, but Excel is a good alternative. There is a video on CourseSites for it too). These come often on FRQs (Free Response Questions).

Remember to always spread the data out to make full use of the graph's axes and label them with titles and the correct units. Do not break the graph unless absolutely necessary and then put a title on too.

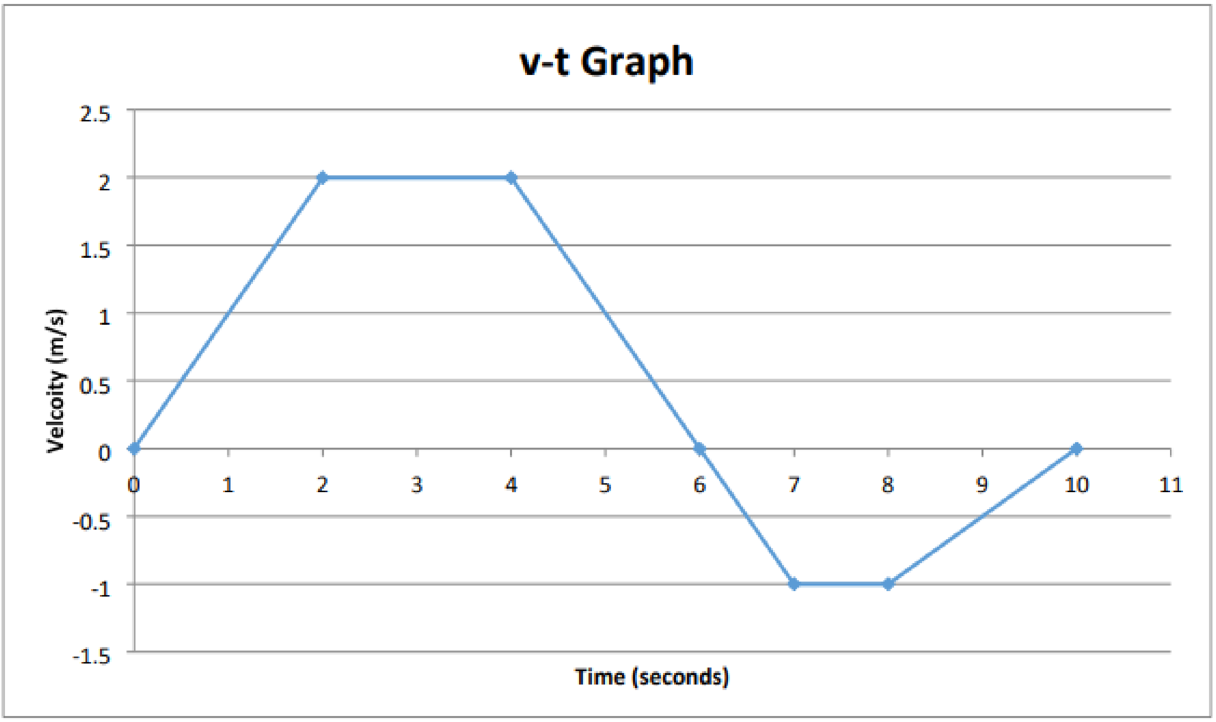
24. Take the following data and create a distance versus time graph (get used to having time on the x-axis). Never connect the dots as it is a scatter plot.

Distance (m)	Time (s)
0.0	0.0
3.6	1.0
7.1	2.0
11.1	3.0
14.6	4.0
18.2	5.0

25. Add in a best-fit line with a straight edge. Write briefly what two things make a "best-fit line".

26. What relationship is found between the distance and time?

Graphing/Data Analysis Cont.



This graph depicts a car starting from rest and moving to the right (positive direction). Interpret the graph and answer the questions below and remember to show your work when calculating.

27. What is the slope of the line from 4 seconds to 7 seconds?

28. What is the area under the curve between 0 seconds and 2 seconds?

29. At what time(s) is the car not moving?

30. During which period of time is the car moving to the left?

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/s^2 down, 3 N out, etc.)

Length of vectors are proportional to their magnitude:

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)

o Vectors can be positive or negative at any time.

o The negative is not a value less than zero as it is in math but an identification of the direction it is traveling.

o 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

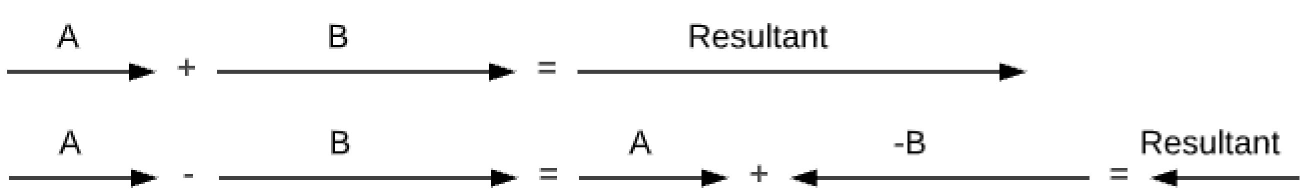
Vectors can be moved to any location as long as direction and magnitude are not altered.

Vector Math:

You can add or subtract vectors but you can always use addition but sometimes with a negative number (subtraction).

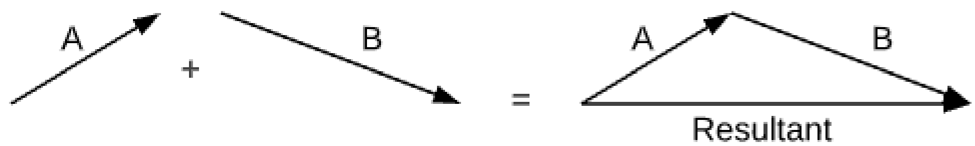
o **Resultant**: The result of adding vectors

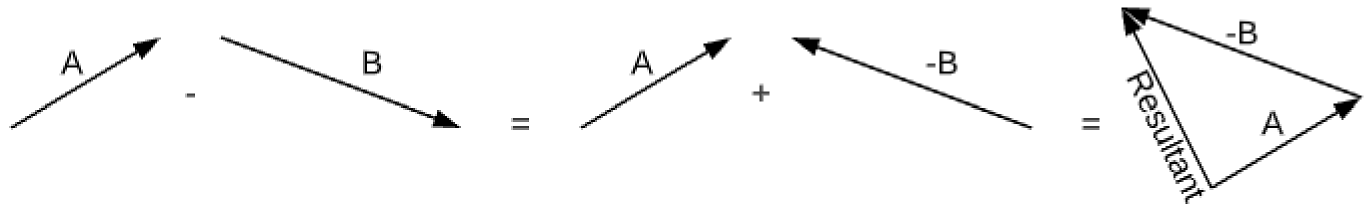
▪ When adding vectors, there are two methods: *tip-to-tail and mathematical components*.



Vector Math Cont.

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





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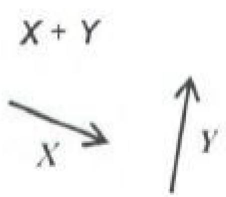

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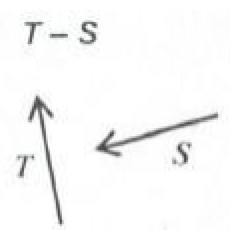

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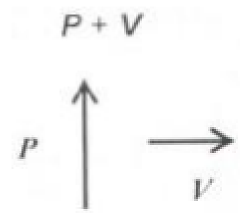

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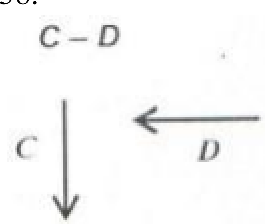
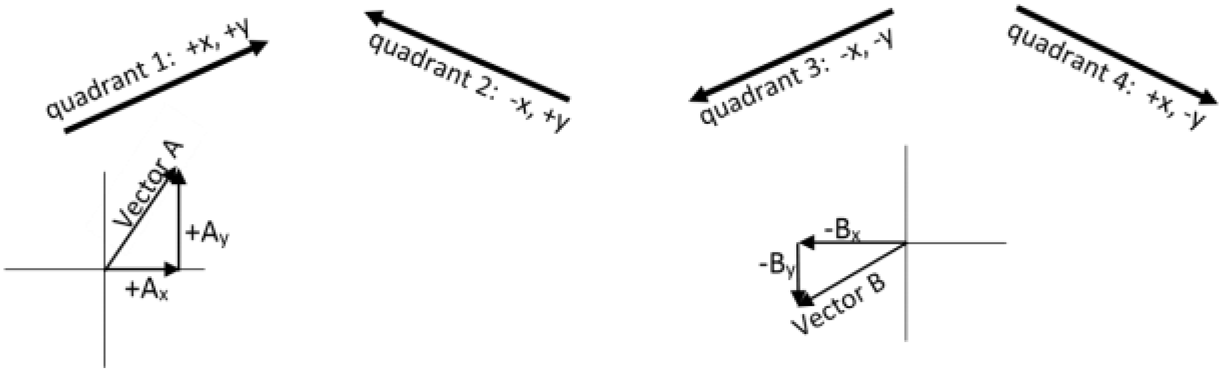
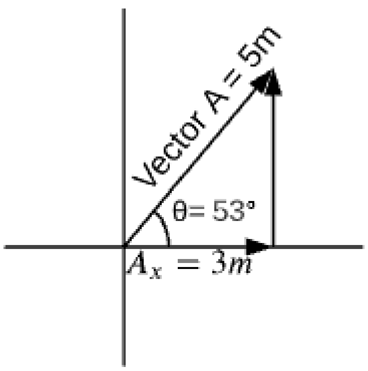


The above examples demonstrated the ***head-to-tail*** or ***tip-to-tail method*** where you can move vectors around as long as the head/tip of one vector touches the tail (back end) of the next vector. The resultant will start at the tail end of the first vector and move in a straight path to the head/tip 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.

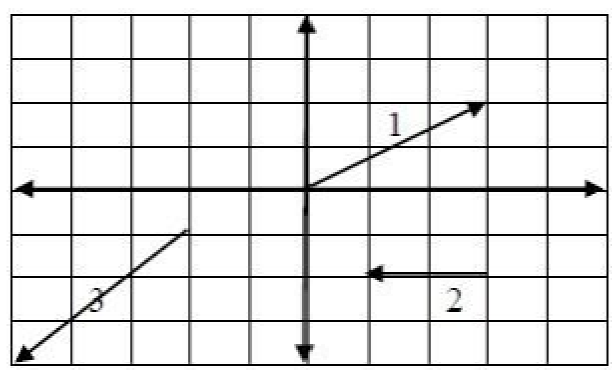


Vector A has a magnitude of 5 m and a direction of 53° above the x-axis. Using trigonometry, you can find the sides and the missing angles,
∴ (means therefore) the horizontal x-component is 3 m and the vertical component is 4 m.

The Pythagorean theorem 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)



39. Vector 1 x-component:
y-component:

40. Vector 2 x-component:
y-component:

41. Vector 3 x-component:
y-component:

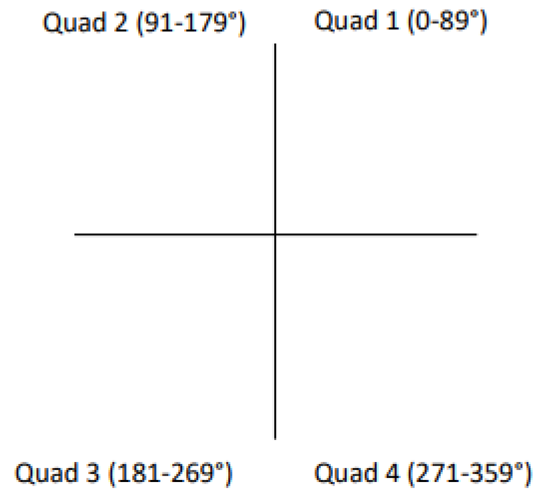
Given a vector (magnitude and direction), you should now be able to graph it on a coordinate plane and using trigonometry find the x- and y-components. Remember to keep your calculator in Degree Mode (i.e. not Radians).

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

42. 15 m @ 77°

43. 8.0 m @ 235°

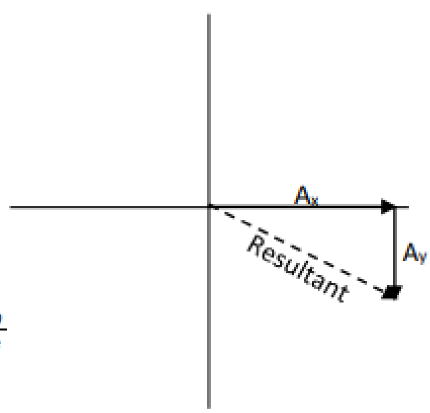
44. 11 m @ -45° (think about it – negative)



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



Resultant is 11 m @ 333° $\sqrt{10^2 + -5^2} = 11\ m$

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

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

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

45. x = 200, y = 100

46. x = -100, y = 75

47. x = -25, y = -45

48. x = 30, y = -60

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

49. Describe in your own words the meaning of a vector's magnitude.

50. Differentiate between displacement and distance and include the following: when are they ever the same and when are they different?

51. Do the same as above for question 50 but for speed and velocity.

52. How does acceleration relate to velocity and give an example of when one would experience a negative acceleration?

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

Lesson 2

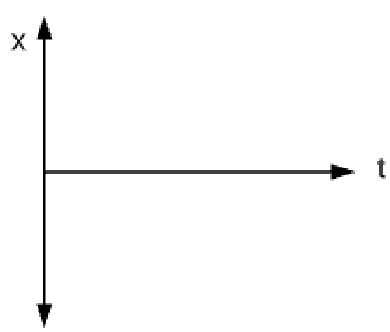
53. Draw an example of a ticker-tape diagram for an automobile accelerating from rest and moving to the right.

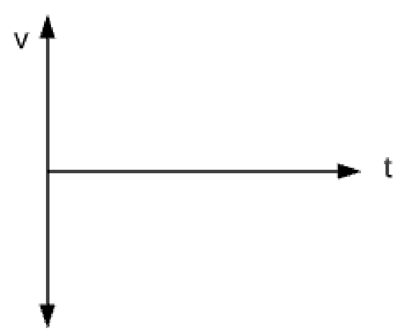
54. Draw a vector diagram for the same thing as 53.

Lesson 3 & 4

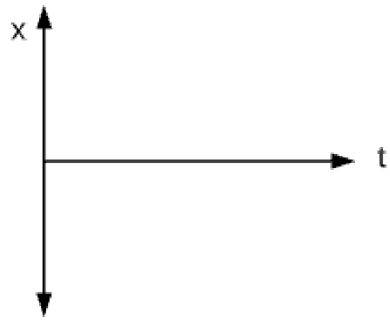
55. Sketch a position versus time (position-time or x-t) graph and a velocity versus time (v-t) graph for each of the following scenarios (assume right is positive for both displacement and velocity):

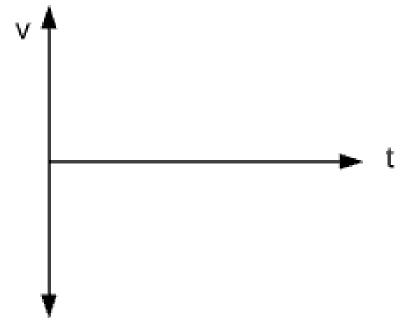
a. A car moving to the right at a constant velocity



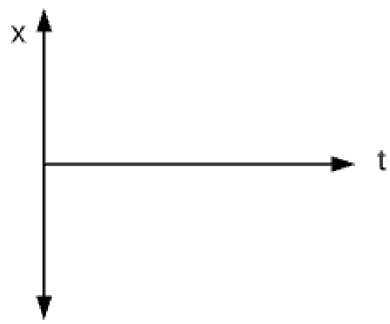


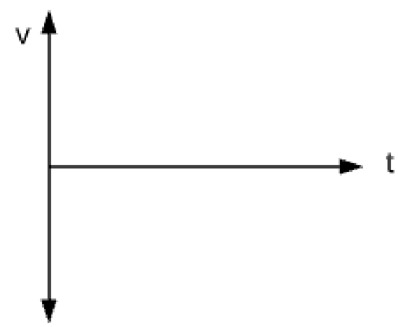
b. A car moving the right with an increasing velocity





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





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

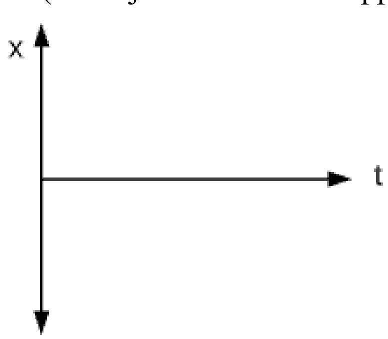
Lesson 5

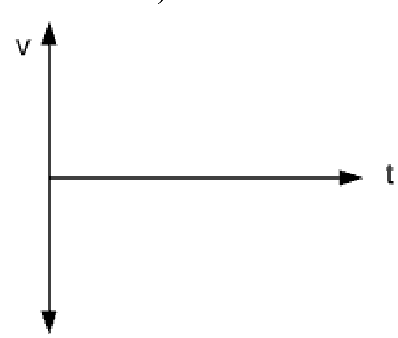
56. What is the symbol for gravity and what value does it represent (memorize both for the whole year!)?

57. What is the total field gravitational value for "Jacksonville"? Use the widget at the bottom of the page.

58. Explain the term "free fall" in your own words.

59. 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).





60. What value would the acceleration on the object above have now? Does it change anytime during its fall? Describe the motion of its fall.

61. 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!):

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

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

62. 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).