AP PHYSICS 1 - SUMMER ASSIGNMENT FOR 2018-2019

By Dr. Knauth

dknauth@bcps.org

Woodlawn High School

1801 Woodlawn Drive

Baltimore, MD 21207

Dear Student: The AP physics course you have signed up for is designed to introduce you to a first semester algebra-based physics course similar to what you would experience in a college setting. Upon successful completeion of the course and a passing grade on the AP Physics 1 test, you could earn college credit, therefore this is a rigorous course in the fundamentals of physics. To aid in your experience, some work must be done at home. This summer packet is designed to introduce you to the fundamental skills you will need to have in order to be successful throughout the year.

The material which describes the first few chapters of the book can be found on the physics classroom website with worked examples, I am including other web resources that you can use to become familiar with the following topics: 1 D kinematics, 2 D kinematics and vectors that form the basis of the first quarter of the course starting in the fall semester of 2018. This summer packet includes several problems per topic that you should complete prior to coming back to school this fall. Unless you already own one, please plan on **purchasing a $10 dollar scientific calculator**, one with the trigonometry functions sin, cos, and tan (e.g., **TI 30 IIXS** ). It **does not** have to be a graphing calculator (e.g., **TI-84** ).

This summer assignment is worth 100 homework points and is **due at the beginning of class Wednesday 9-05-2018**. Please answer in legible handwriting on this document and extra paper, with clear headings and your name. I will not accept summer assignment after the first two weeks of the course so have it ready to hand it in. There will be a quiz on that first day of class with similar.

For each problem in the packet, please show all your work, (Note: if insufficient work is shown because it was all done on your calculator, you will earn at most half the credit for that problem). I will be available periodically during the summer break, you may contact me by e-mail if you are having problems with the assignment. You should aim to start the assignment as soon as possible and to complete it before July 1st.

Sincerely,

Dr. Knauth

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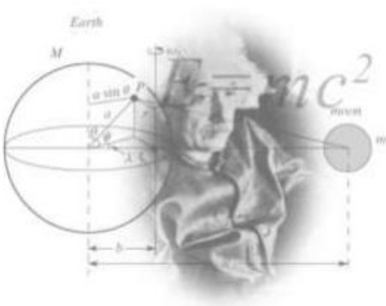
Email me if you have any questions at dknauth@bcps.org. Generally, I check email once a week during the summer.



Although we will not be using the APlus physics textbook in class there are videos that discuss the basics of physics at the following web site:

- http://www.aplusphysics.com/courses/ap-1/AP1_Physics.html

AP Physics 1 Videos

A. Introduction
A. What Is Physics?
B. Which AP Physics Course Should I Take?
B. Math Review
. Significant Figures
A. Scientific Notation
B. Metric System
C. Vectors and Scalars
C. Mechanics
. Kinematics
a. Defining Motion
b. Graphing Motion
c. Kinematic Equations
d. Free Fall
e. Projectile Motion
a. Horizontal Projectile Practice
b. Angled Projectile Practice
f. Relative Motion
. PSSC: Frames of Reference
g. Center of Mass
A. Dynamics
. Newton's 1st Law
a. Free Body Diagrams
b. Newton's 2nd Law
c. Newton's 3rd Law
d. Friction
e. Air Resistance
f. Elevators
g. Ramps and Inclines
h. Atwood Machines
B. Work, Energy, & Power
. Work
a. Power
b. Energy
c. Springs and Hooke's Law
d. Work-Energy Theorem
e. Conservation of Energy
f. Work, Energy, and Power in Crossfit Problems
g. Work, Energy, and Power in Crossfit Solutions
C. Momentum
. Momentum & Impulse
a. Impulse-Momentum Theorem
b. Conservation of Momentum
c. Collisions in Multiple Dimensions

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Other Web Resources

- Educator.com: AP Physics 1 and AP Physics 2 - https://www.educator.com/physics/ap-physics-1-2/fullerton/
- AP Physics 1 on Youtube https://www.youtube.com/playlist?list=PLd2HWlWc-MsysWuL9ksneEM8cl5bk3bHH
- the Physics Classroom http://www.physicsclassroom.com
- edX Preparing for the AP Physics 1 Exam Online Course https://www.edx.org/course/preparing-ap-physics-1-exam-bux-py1x-0
- edX Challenging Concepts from Physics 1 & Physics 2 https://www.edx.org/course/apr-physics-1-challenging-concepts-davidson-next-phy1apccx-0

This assignment is due on the first day of school. You must show all your work in all steps. **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! Physics, and AP Physics in particular, is a science course that will demand an exceptional knowledge of algebra-based mathematics, trigonometry, and geometry. It will sometimes feel as if you are in another mathematics class that consists of only word problems. Because much of physics requires application of algebraic mathematics, it is strongly recommended that students have a solid mathematical foundation before entering this class to be successful. AP Physics I is not just about testing you math skills, many questions probe your knowledge on key physics concepts. Every test is approximately 50% math and 50% conceptual knowledge. Every student has the ability to earn a passing grade in physics, keep trying even when the going gets tough. Attend coach class and redo assignments within the two week window to improve your understanding and you grade.

PART I. Basic Algebra skills – each of these concepts will be taught at some point in the year so if you struggle don't fret, you will get it at the right time.

1. Kinetic energy is a property of all moving matter, the formula is as follows: Kinetic energy equals ½ the mass times the square of the velocity (KE = 1/2 mv^2)

   A 250 kg object is traveling at a speed of 12.5 m/s, what is the objects kinetic energy?

   $KE = 1/2 \cdot 250\ kg \cdot (12.5\ m/s)^2 =$

2. The gravitational force of attraction was first discovered by Isaac Newton after he invented calculus. The force equation is as follows: the gravitational force is equal the force constant times the mass of each object divided by the square of the distance separation. $F = G\ M_1M_2$ r^2, where G is always equal to $6.67 \cdot 10^{-11}\ Nm^2/kg^2$

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What is the gravitational force of attraction between the Earth ($m_1 = 5.98 \cdot 10^{24} kg$ and the Sun $m_2 = 1.99 \cdot 10^{30} kg$?

$F = [(6.67 \cdot 10^{-11}\ Nm^2/kg^2) \cdot (5.98 \cdot 10^{24} kg)(1.99 \cdot 10^{30} kg)]/(1.51 \cdot 10^{15}\ m)^2 =$

3. Resistors connected in a parallel circuit can be combined to determine the equivalent resistance of a circuit. The formula is as follows:

$1/R_{eq} = 1/R_1 + 1/R_2 + \cdots$

$1/R_{eq} = 1/24\ \Omega + 1/18\ \Omega =$

4.The torque on an object

$\tau = rF \sin\theta$

$\tau = 1.4m \cdot 28N \sin 47° =$

4. The period of a pendulum.

   $T = 2\pi\sqrt{}\ (l\ g)$

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

Once again, this will be a daily routine in this class but now you must do it with only 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. $P = \Delta W/\Delta t$; solve for Δt
8. $a_c = v^2/r$; solve for v
9. E = 1/2 mv^2 ; solve for v
10. $y_f = y_i + v_i\, t + 1/2\ at^2$; solve for a
11. $F = k\ q_1 q_2\ r^2$; solve for q_2
12. $R = \rho\ l/A$; solve for ρ
13. $v_f{}^2 = v_i{}^2 - 2a(x_f - x_i)$; solve for x_i
14. $n_1 \sin\theta_1 = n_2 \sin\theta_2$; solve for θ_2
15. $T = 2\pi\sqrt{}\ (mk)$; solve for k

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PART II. Geometry and Unit Conversion review

Complete the following tables:

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

-

Metric Prefix	**Power**	**Symbol**
Tera-		
Giga-		
Mega-		
kilo-	10^3	k
base unit	10^0	-
centi-		
milli-		
micro-		
nano-		
pico-	10^{-12}	p

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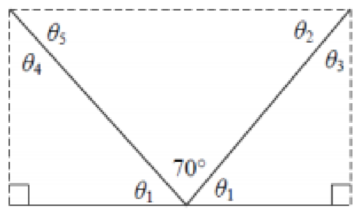
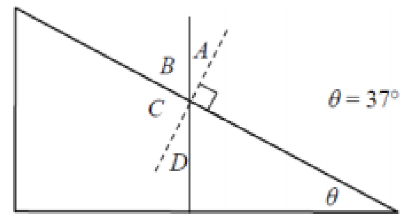
Solve for the missing angles in the following problems:

16.



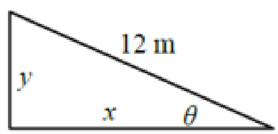
Solve for angles 1-5.

17.



Solve for angles A-D.

18. Solve for the missing sides:

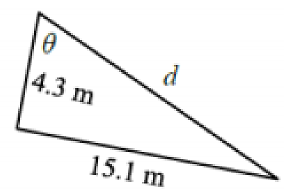


$\theta = 30°$

$y =$ ________

$x =$ ________

19. Solve for missing side and angle:

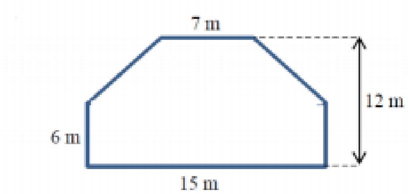


$d =$ _______

$\theta =$ _______

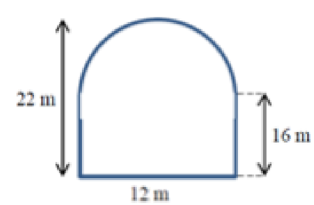
Solve for the area in the following problems:

20.



Area = ________

21.



Area = ________

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

22. 35 kg → g

23. 1.8μm → m

24. 9 MJ → cJ

25. 7.2 cm^2 → m^2

26. 81 m^3 → km^3

27. 31 km/hr → m/s

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Part III: Graphing and Data Analysis

You should be able to create and interpret data using graphical techniques as well as algebraically. In a scatter plot, never connected the dots, but you should draw a line of best fit. The x-axis is the independent variable (usually time) and the y-axis is always the dependent variable.

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

28. 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

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

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

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Part III: Graphing/Data Analysis (continued)

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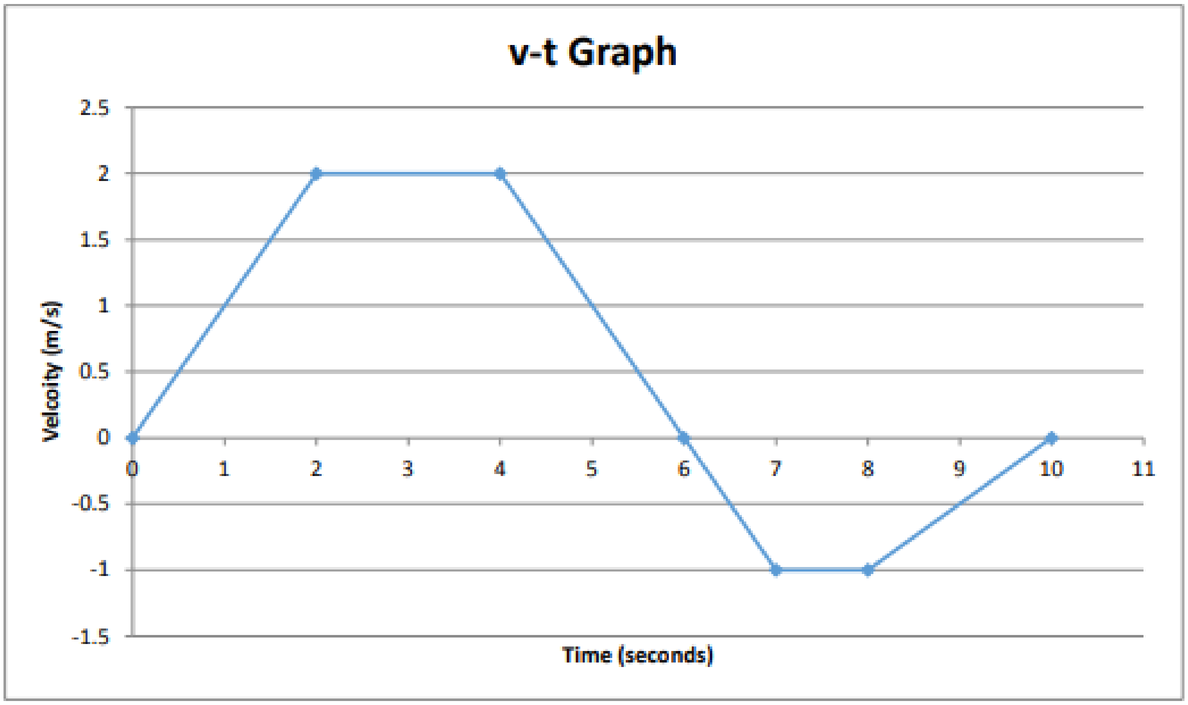

This graph depicts a car starting from rest and moving to the right (positive direction). Interpret the graph and answer the questions below and remember to show your work when calculating.

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

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

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

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

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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: 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.

A → ← -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*.

A → + B → = Resultant →

A → - B → = A → + ← -B = Resultant ←

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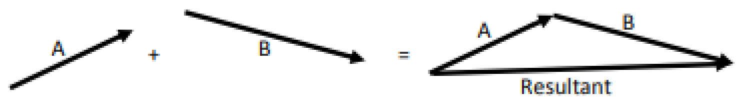
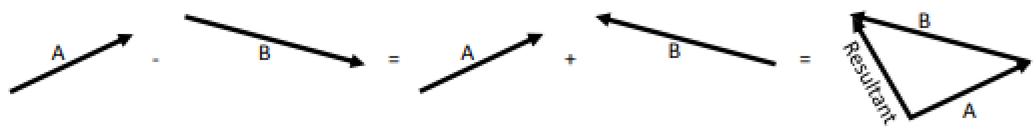
Vector Math Cont.

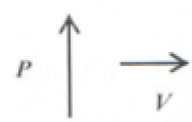
This tip-to-tail method can also be done in two-dimensions



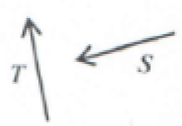


35. $X + Y$

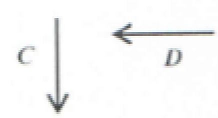
37. $P + V$



36. $T - S$

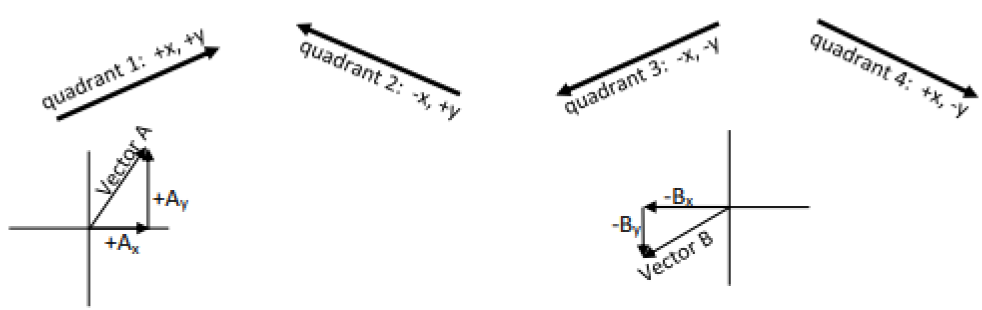


38. $C - D$



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).



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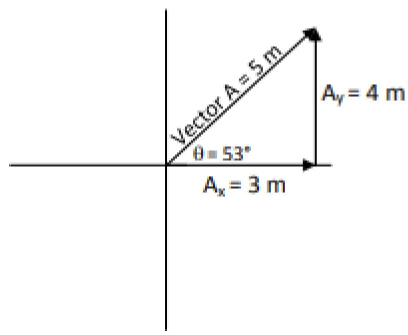
<u>Vector Math Cont.</u>



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

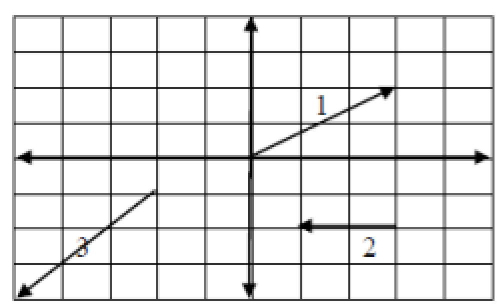
Using trigonometry, you can find the sides and the missing angles

∴ (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)

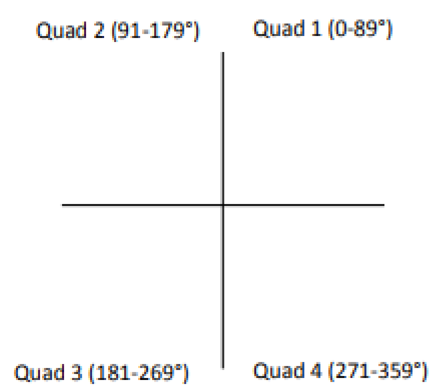
39. Vector 1
    - x-component:
    - y-component:
40. Vector 2
    - x-component:
    - y-component:
41. Vector 3
    - x-component:
    - y-component:



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.

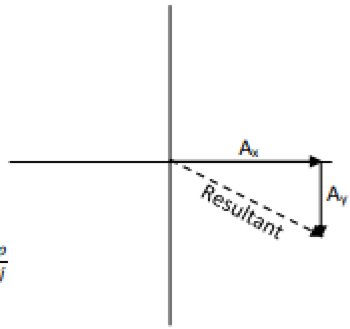
e.g. $A_x = 10$ m, $A_y = -5.0$ m

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

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

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

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



Resultant is 11 m @ 333°

45. x = 200, y = 100

46. x = -100, y = 75

47. x = -25, y = -45

48. x = 30, y = -60

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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?

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<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 to the right with an increasing velocity

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

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

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!):

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

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

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 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).