Name: Block

AP Physics 1: Summer Assignment 2026-2027 School Year

Purpose: This summer assignment is to intended to help you to become familiar with the basic math skills required to be successful in AP Physics 1. Failure to work through this summer assignment will put you at a disadvantage throughout the year. Your focus should be to understand the material in this handout, not to rush through and complete this assignment.

For additional support on each subject, please reference the following links:

1) **Algebra**
   - a. https://www.khanacademy.org/math/algebra-home
     - i. Or Google 'Khan Academy Algebra'
2) **Trigonometry**
   - a. https://www.khanacademy.org/math/trigonometry
     - i. Or Google ' Khan Academy Trigonometry'
   - b. https://math.libretexts.org/Courses/Fullerton_College/Math_100%3A_Liberal_Arts_Math_(Claassen_and_Ikeda)/02%3A_Geometry/2.10%3A_Right_Triangle_Trigonometry
     - i. Or Google ' Libretexts Right Tirangle Trigonometry;
3) **Vectors:**
   - a. https://www.khanacademy.org/math/precalculus/x9e81a4f98389efdf:vectors
     - i. Or Google ' Khan Academy Vectors'
   - b. https://brilliant.org/courses/vectors/
     - i. Or Google ' Brilliant Vectors'
4) **Interpreting Graphs:**
   - a. https://www.khanacademy.org/math/algebra/x2f8bb11595b61c86:linear-equations-graphs/x2f8bb11595b61c86:slope/e/slope-from-a-graph
     - i. Or Google ' Khan Academy Solpe of Graph'
   - b. https://www.physicsclassroom.com/class/1DKin/Lesson-4/Determining-the-Area-on-a-v-t-Graph
     - i. Or Google 'The Physics Classroom Determining the Area on a vt graph'
5) **Mathematical Models – Understanding and Creating Graphs**
   - a. https://science.clemson.edu/physics/labs/tutorials/graph/index.html
     - i. Or Google ' Clemson Physics Graphs'
   - b. https://phys.libretexts.org/Courses/University_of_California_Davis/UCD%3A_Physics_9HA__Classical_Mechanics/1%3A_Motion/1.5%3A_Graphing
     - i. Or Google ' LibreText Physics Graphing'
6) **Graph Linearization:**
   - a. https://quarknet.org/content/how-linearize-curved-data-plot
     - i. Or Google 'Quarknet Linearize Curved Data'

AP Physics 1 Summer Assignment

1. Scientific Notation:

The following are ordinary physics problems. Write the answer in scientific notation and simplify the units (π=3).

a. $T_s = 2\pi\sqrt{\dfrac{4.5\times10^{-2}\,kg}{2.0\times10^{3}\,kg/s^2}} =$ =_____

b. $F = \left(9.0\times10^{9}\,\dfrac{N\cdot m^2}{C^2}\right)\dfrac{\left(3.2\times10^{-9}C\right)\left(9.6\times10^{-9}C\right)}{\left(0.32m\right)^2}$ F=_____

c. $\dfrac{1}{R_p} = \dfrac{1}{4.5\times10^{2}\,\Omega} + \dfrac{1}{9.4\times10^{2}\,\Omega}$ =_____

d. $K_{max} = \left(6.63\times10^{-34}\,J\cdot s\right)\left(7.09\times10^{14}s^{-1}\right) - 2.17\times10^{-19}\,J$ =_____

e. $\gamma = 1\Big/\sqrt{1-\dfrac{2.25\times10^{8}\,m/s}{3.00\times10^{8}\,m/s}}$ γ=_____

f. $K = \dfrac{1}{2}\left(6.6\times10^{2}\ \text{kg}\right)\left(2.11\times10^{4}\ \text{m/s}\right)^2 =$ =_____

g. $\left(1.33\right)\sin 25.0^\circ = \left(1.50\right)\sin\theta$ θ=_____

2. Solving Equations:

Often problems on the AP exam are done with variables only. Solve for the variable indicated. Don't let the different letters confuse you. Manipulate them algebraically as though they were numbers.

a. $K = \frac{1}{2}kx^2$, $x =$ _____

b. $T_p = 2\pi\sqrt{\frac{\ell}{g}}$, $g =$ _____

c. $F_g = G\frac{m_1 m_2}{r^2}$, $r =$ _____

d. $mgh = \frac{1}{2}mv^2$, $v =$ _____

e. $x = x_o + v_o t + \frac{1}{2}at^2$, $t =$ _____

f. $B = \frac{\mu_o}{2\pi}\frac{I}{r}$, $r =$ _____

g. $x_m = \frac{m\lambda L}{d}$, $d =$ _____

h. $pV = nRT$, $T =$ _____

i. $\sin\theta_c = \frac{n_1}{n_2}$, $\theta_c =$ _____

j. $qV = \frac{1}{2}mv^2$, $v =$ _____

3. Conversion

Science uses the ***KMS*** system (***SI***: System Internationale). ***KMS*** stands for kilogram, meter, second. These are the units of choice of physics. The equations in physics depend on unit agreement. So you must convert to ***KMS*** in most problems to arrive at the correct answer.

kilometers (*km*) to meters (*m*) and meters to kilometers
centimeters (*cm*) to meters (*m*) and meters to centimeters
millimeters (*mm*) to meters (*m*) and meters to millimeters
nanometers (*nm*) to meters (*m*) and metes to nanometers
micrometers (μm) to meters (*m*)
gram (*g*) to kilogram (*kg*)
Celsius (^oC) to Kelvin (*K*)
atmospheres (*atm*) to Pascals (*Pa*)
liters (*L*) to cubic meters (m^3)

Other conversions will be taught as they become necessary.

What if you don't know the conversion factors? Colleges want students who can find their own information (so do employers). Hint: Try a good dictionary and look under "measure" or "measurement". Or the Internet? Enjoy.

a. 4008 *g* = _____ *kg*

b. 1.2 *km* = _____ *m*

c. 823 *nm* = _____ *m*

d. 298 *K* = _____ ^oC

e. 0.77 *m* = _____ *cm*

f. 8.8×10^{-8} *m* = _____ *mm*

g. 1.2 *atm* = _____ *Pa*

h. 25.0 μm = _____ *m*

i. 2.65 *mm* = _____ *m*

j. 8.23 *m* = _____ *km*

k. 40.0 *cm* = _____ *m*

l. 6.23×10^{-7} *m* = _____ *nm*

m. 1.5×10^{11} *m* = _____ *km*

4. Geometry

Solve the following geometric problems.

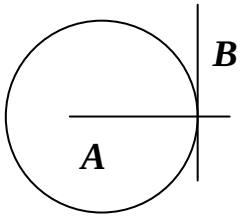
a. Line ***B*** touches the circle at a single point. Line ***A*** extends through the center of the circle.

i. What is line ***B*** in reference to the circle?

_____

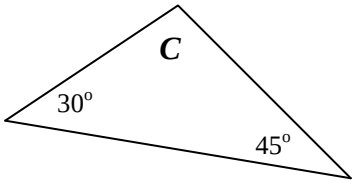
ii. How large is the angle between lines ***A*** and ***B***?

_____



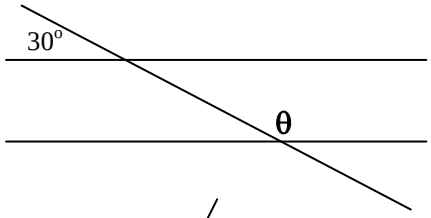
b. What is angle ***C***?

_____



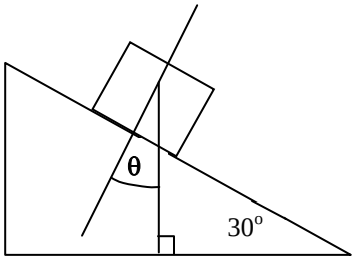
c. What is angle θ ?

_____



d. How large is ***θ***?

_____



e. The radius of a circle is 5.5 *cm*,

i. What is the circumference in <u>meters</u>?

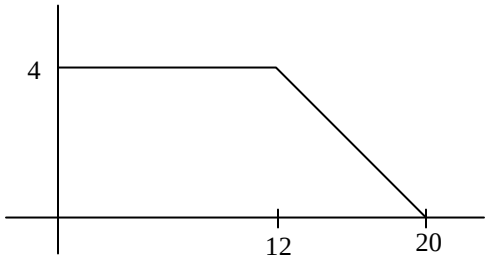
_____

ii. What is its area in <u>square meters</u>?

_____

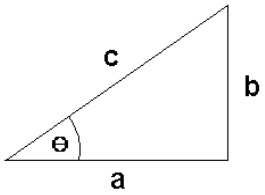
f. What is the area under the curve at the right?

_____



5. Trigonometry

Using the generic triangle to the right, Right Triangle Trigonometry and Pythagorean Theorem solve the following. ***Your calculator must be in degree mode.***



g. $\theta = 55^{o}$ and $\boldsymbol{c} = 32\ m$, solve for $\boldsymbol{a}$ and $\boldsymbol{b}$.

_____

h. $\theta = 45^{o}$ and $\boldsymbol{a} = 15\ m/s$, solve for $\boldsymbol{b}$ and $\boldsymbol{c}$.

_____

i. $\boldsymbol{b} = 17.8\ m$ and $\theta = 65^{o}$, solve for $\boldsymbol{a}$ and $\boldsymbol{c}$.

_____

j. $\boldsymbol{a} = 250\ m$ and $\boldsymbol{b} = 180\ m$, solve for θ and $\boldsymbol{c}$.

_____

k. $\boldsymbol{a} = 25\ cm$ and $\boldsymbol{c} = 32\ cm$, solve for $\boldsymbol{b}$ and θ.

_____

l. $\boldsymbol{c} = 104\ cm$ and $\boldsymbol{b} = 65\ cm$, solve for $\boldsymbol{a}$ and θ.

_____

Vectors

Most of the quantities in physics are vectors. ***<u>This makes proficiency in vectors extremely important</u>***.

Magnitude: Size or extend. The numerical value.

Direction: Alignment or orientation of any position with respect to any other position.

Scalars: A physical quantity described by a single number and units. A quantity described by **<u>magnitude only</u>**.

Examples: time, mass, and temperature

Vector: A physical quantity with **<u>both a magnitude and a direction</u>**. A directional quantity.

Examples: velocity, acceleration, force

Notation: $\vec{A}$ or $\overrightarrow{\quad A \quad}$ <u>Length</u> of the arrow is <u>proportional to the vectors magnitude</u>.
<u>Direction</u> the arrow points <u>is the direction of the vector</u>.

Negative Vectors

Negative vectors have the same magnitude as their positive counterpart. They are just pointing in the opposite direction.

$\overrightarrow{\quad A \quad}$ $\qquad$ $\overleftarrow{\quad -A \quad}$

Vector Addition and subtraction

Think of it as vector addition only. The result of adding vectors is called the <u>result</u>ant. $\vec{R}$

$\vec{A}+\vec{B}=\vec{R}$ $\qquad$ $\overrightarrow{\quad A \quad}$ + $\overrightarrow{\quad B \quad}$ = $\overrightarrow{\qquad R \qquad}$

So if ***A*** has a magnitude of 3 and ***B*** has a magnitude of 2, then ***R*** has a magnitude of 3+2=5.

When you need to subtract one vector from another think of the one being subtracted as being a negative vector. Then add them.

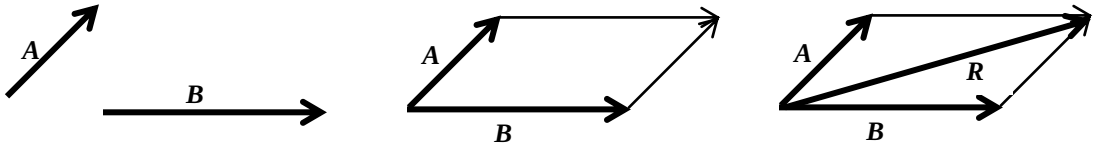
A negative vector has the same length as its positive counterpart, but its direction is reversed.
So if ***A*** has a magnitude of 3 and ***B*** has a magnitude of 2, then ***R*** has a magnitude of 3+(-2)=1.

<u>This is very important</u>. In physics a negative number does not always mean a smaller number. Mathematically –2 is smaller than +2, but in physics these numbers have the same magnitude (size), they just point in different directions (180^o apart).

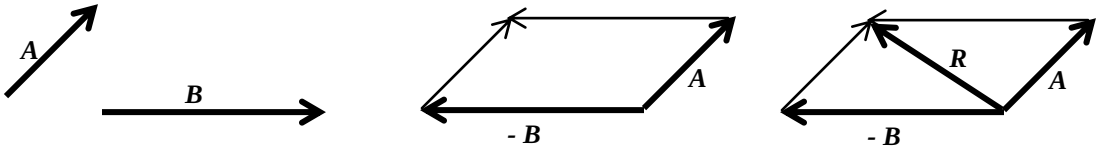
There are two methods of adding vectors

Parallelogram

A + ***B***

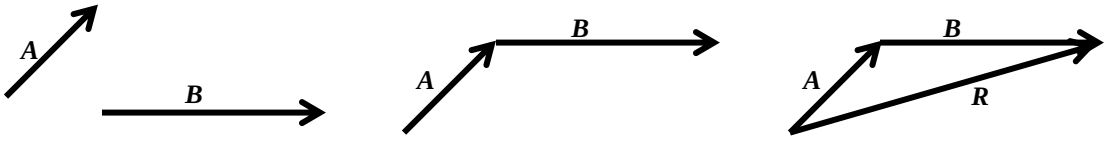


A – ***B***

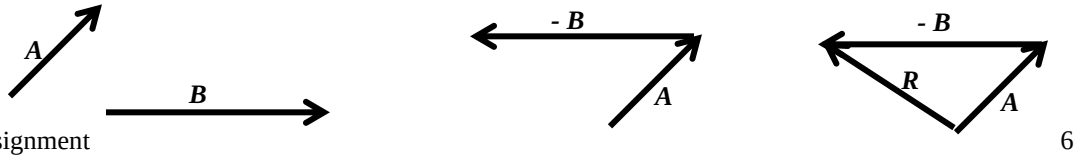


Tip to Tail

A + ***B***

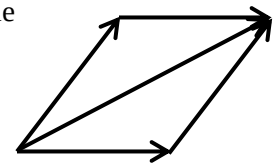


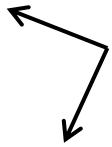
A – ***B***

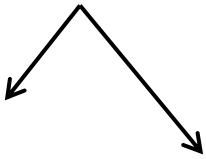


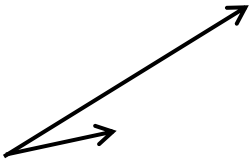
6. Drawing Resultant Vectors

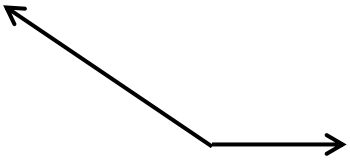
Draw the resultant vector using the parallelogram method of vector addition.

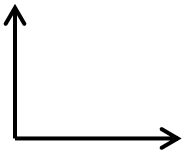
Example 

b. 

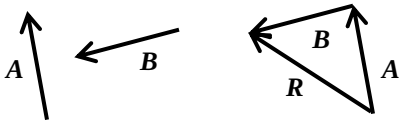
d. 

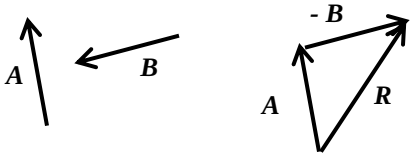
a. 

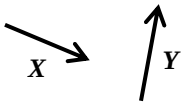
c. 

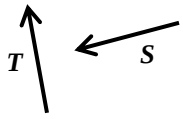
e. 

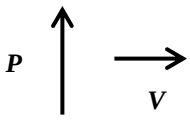
Draw the resultant vector using the tip to tail method of vector addition. Label the resultant as vector ***R***

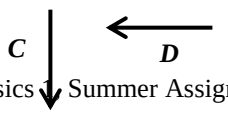
Example 1: ***A*** + ***B*** 

Example 2: ***A*** – ***B*** 

f. ***X*** + ***Y*** 

g. ***T*** – ***S*** 

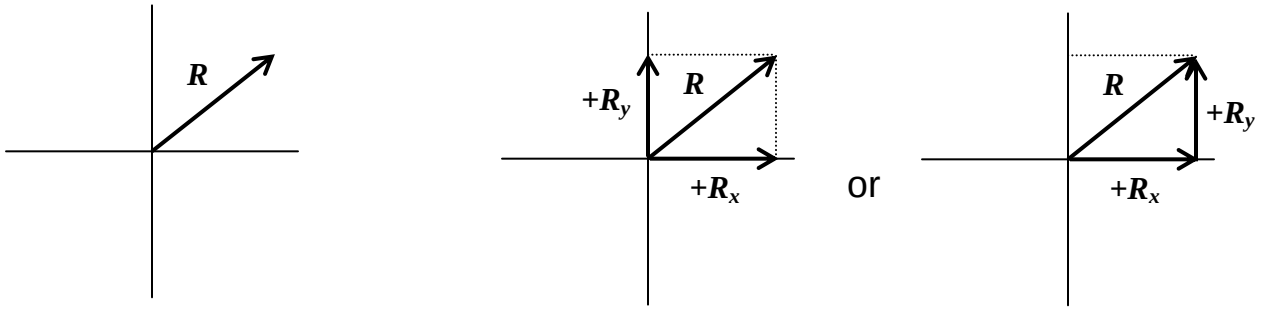
h. ***P*** + ***V*** 

i. ***C*** – ***D*** 

Component Vectors

A resultant vector is a vector resulting from the sum of two or more other vectors. Mathematically the resultant has the same magnitude and direction as the total of the vectors that compose the resultant. Could a vector be described by two or more other vectors? Would they have the same total result?

This is the reverse of finding the resultant. You are given the resultant and must find the component vectors on the coordinate axis that describe the resultant.

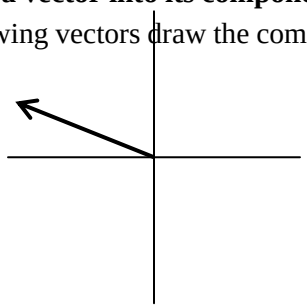


Any vector can be described by an ***x*** axis vector and a ***y*** axis vector which summed together mean the exact same thing. The advantage is you can then use plus and minus signs for direction instead of the angle.

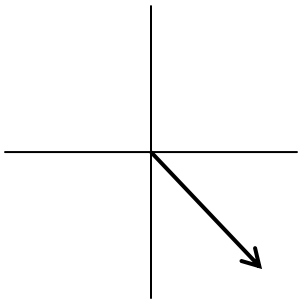
7. Resolving a vector into its components

For the following vectors draw the component vectors along the ***x*** and ***y*** axis. Use colored pencils/pens

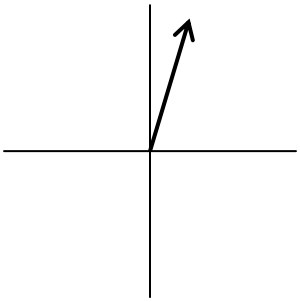
a.



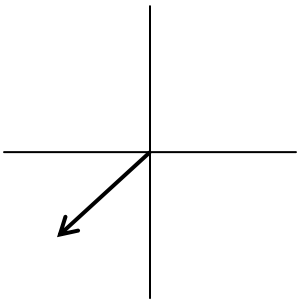
c.



b.



d.

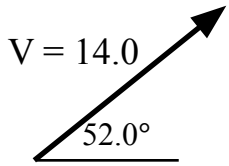


Obviously the quadrant that a vector is in determines the sign of the ***x*** and ***y*** component vectors.

Vector Components

Find the vertical (y) and horizontal (x) components of the following vectors

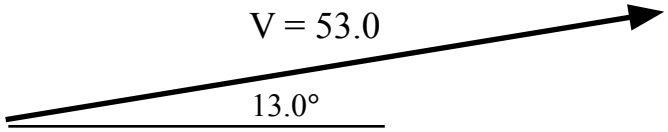
1.



V_h = _____

V_v = _____

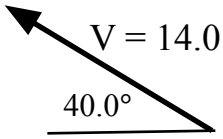
2.



V_h = _____

V_v = _____

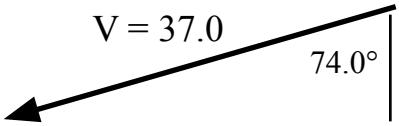
3.



V_h = _____

V_v = _____

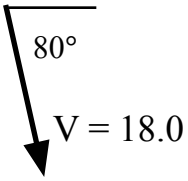
4.



V_h = _____

V_v = _____

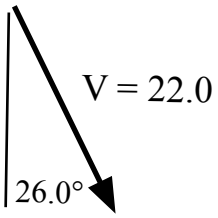
5.



V_h = _____

V_v = _____

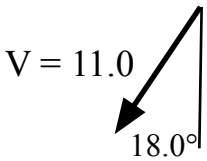
6.



V_h = _____

V_v = _____

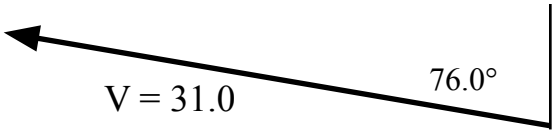
7.



V_h = _____

V_v = _____

8.



V_h = _____

V_v = _____

9. A car is driven 80 km west and then 30 km 45° south of west. What is the displacement of the car from the point of origin? (magnitude and displacement)

10. A delivery truck travels 18 blocks north, 10 blocks east, and then 20 blocks south. What is the truck's final displacement from its starting point? Assume the blocks are all equal length.

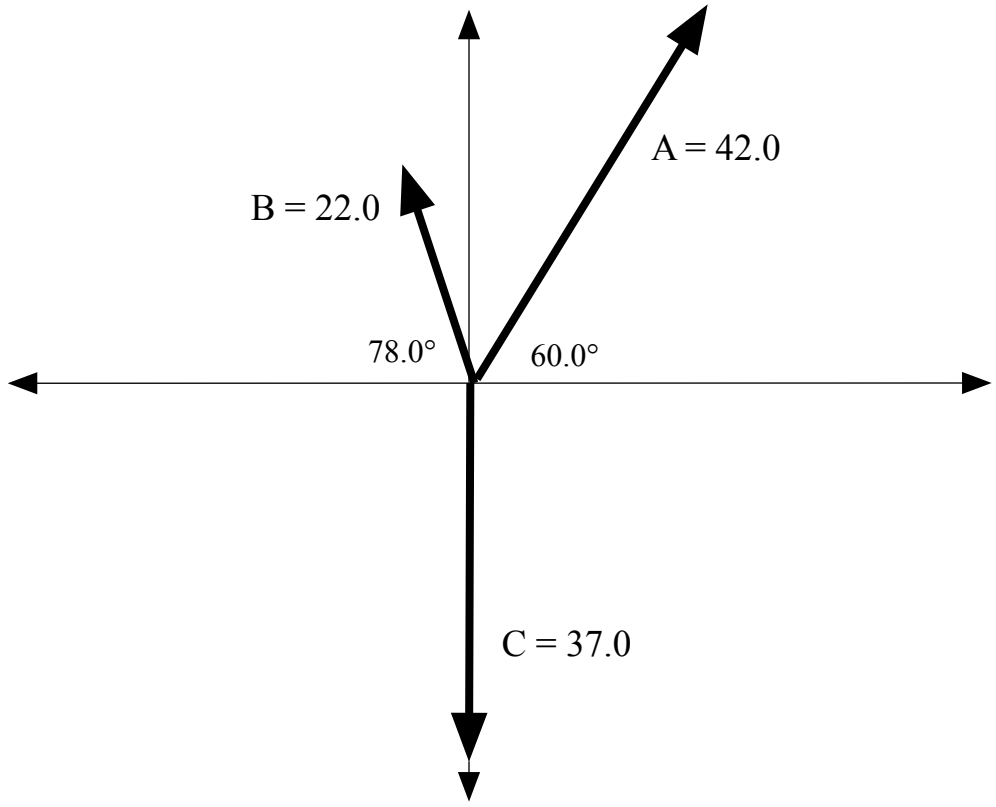
11. Given the following two vectors, where Vector A is 6.3 meters and Vector B is 3.5 meters:

Determine the magnitude of the following vector sums:

a. A + B b. A - B c. B - A

12. If vector component V_h is -8.50 units and V_v is 4.80 units, what is the magnitude and direction of Vector V?

13. Given the three vectors shown below:



Calculate the following vector sums:

a. A + B + C b. A - C

c. B - A d. B - C

e. A - B + C f. A + B - C

8. Algebraic Relationships

Consider the following: $z = \frac{x}{y}$ $c = ab$ $l = m\sqrt{n}$ $r = \frac{s^2}{t^2}$

31. As *x* increases and *y* stays constant, *z* _____.
32. As *y* increases and *x* stays constant, *z* _____.
33. As *x* increases and *z* stays constant, *y* _____.
34. As *a* increases and *c* stays constant, *b* _____.
35. As *c* increases and *b* stays constant, *a* _____.
36. As *b* increases and *a* stays constant, *c* _____.
37. As *n* increases and *m* stays constant, *l* _____.
38. As *l* increases and *n* stays constant, *m* _____.
39. If *s* is tripled and *t* stays constant, *r* is multiplied by _____.
40. If *t* is doubled and *s* stays constant, *r* is multiplied by _____.

9: Analyzing Linear Motion

Objects have a position (d) at a time (t). If an object is changing its position over time, it is in MOTION. The rate of change in position per unit time is called VELOCITY.

In the following activity, you will collect position and time data from a very simple simulation and then analyze that data by creating a position vs time and a velocity vs time graph for a boat moving at two different speeds. *Have two different color pencils handy because you will be asked to distinguish between trial 1 and trial 2 by graphing etc. in different colors.*

1. Go to the following website: www.thephysicsaviary.com.
2. Click on "Labs" and then "Graphing Motion Simple "
3. Click on **begin**, then play with the program for a few minutes to see what it does.
4. List and describe each parameter and explain how it changes the motion of the boat.
5. Click on reset, and then on paddles. Change at least one parameter.
6. Click return and then start.
7. Trial 1: Collect time data for each of the positions listed in the table. Write down the time that the boat reaches the positions listed as accurately as possible. Be sure to record data in the table provided in the column for trial 1 time data.

Data Table

Time (seconds)		Position (meters)
Trial 1	**Trial 2**	
		0
		100
		200
		300
		400
		500

8. Using the grid provided, plot a Position vs Time graph (often called a x vs t graph). Use a pencil. (Be sure that you graph it correctly. Graph titles should be written as Y-variable vs X-variable)

Position vs. Time

9. Draw a best-fit line for your data points for trial 1 using a ruler. Try to represent the relationship between the position and times as best you can. Go through as many points as you can AND try and end up with an equal number of points on either side of your line. Do not force the line through the origin unless it naturally falls there.

10. Which of the following phrases best describes the slope of your d-t graph?

A. Increasing and positive
B. Decreasing and positive
C. Constant and positive
D. Constant and negative

Justify your answer:

11. Which of the following phrases best **describes** the speed, or velocity, of your boat, if the positive direction is defined as to the left on the computer screen?

A. Increasing and positive

B. Decreasing and positive

C. Constant and positive

D. Constant and negative

Justify your answer:

12. Go to the following webpage: http://www.physicsclassroom.com/class/1DKin/Lesson-3/The-Meaning-of-Shape-for-a-p-t-Graph and, after reading, **explain** the meaning of the slope for a position versus time (d-t) graph.

13. Velocity can be calculated with the simple equation $v = \frac{\Delta d}{\Delta t}$. If Δd means change in position and Δt means change in time, what is the SI unit for velocity?

14. Calculate the average velocity of your boat for trial 1 by calculating the slope of your **best fit line** on the d-t graph. DO NOT USE ACTUAL DATA POINTS TO FIND SLOPE. PICK TWO POINTS FROM THE BEST-FIT LINE AND USE THEM. Every data point has some amount of error associated with it (maybe not so much in this simulation, but in real experimental data!) . The best-fit line is our best indication of the actual relationship between variables, so use it. Show your work clearly.

15. Write an equation for the line in y=mx+b format but use d's and t's instead of y's and x's. ($d=vt+d_i$ instead of y=mx+b)

16. Sketch the velocity of the boat in trial one versus time on the grid below, labeling only the velocity of the boat on the y axis.

Velocity Vs. Time

Trial 2:

17. Click RESET and then change another parameter enough to make the boat move significantly slower or faster.

18. Repeat the entire process, placing the new time data in the column for trial 2 **in another color pencil.**

19. Graph the points for trial 2 on the same position vs time grid but in the same color as trial 2 data.

20. Draw your next best-fit line in the same color you wrote your data down in for trial 2.

21. Calculate the velocity of the boat during trial 2 using your best-fit line. Clearly show your work.

22. Write an equation for the line in y=mx+b format but use d's and t's instead of y's and x's.

23. Sketch the velocity vs. time relationship for trial 2 on the V-t grid

24. ***Compare and contrast*** the slope of the position-time graph for trial 2 with that for trial including an explanation of what the slopes indicate about the motion of the boat in each trial.

25. Compare and contrast the two lines on the velocity-time graph.

26. Go to http://www.physicsclassroom.com/class/1DKin/Lesson-4/Meaning-of-Shape-for-a-v-t-Graph and, after reading, explain the meaning of slope on a v-t graph.

27. Define acceleration. What is the acceleration of the boats during trial 1 and trial 2?

28. The simulation is programmed so that the boat does not cross the zero-meter mark until after it has been moving for a few seconds. Imagine that the boat instead started at rest at the zero-meter mark and then accelerated up to its full speed while you were collecting data.

a. Sketch the d-t and v-t graphs that would result from this motion.