Little Rock Christian Academy
AP Physics 1 – 2020-2021
Instructor: Barry McCaskill

This course is equivalent to a first-semester college course in algebra-based physics. Topics covered include Newtonian mechanics (including rotational dynamics and angular momentum); work, energy, and power; mechanical waves and sound; and electric circuits. Through inquiry- and example-based learning, students will develop critical thinking and reasoning skills along with building their knowledge of scientific principles.

Big Ideas:

1. Objects and systems have properties such as mass and charge. Systems may have internal structure.
2. Fields existing in space can be used to explain interactions.
3. The interactions of an object with other objects can be described by forces.
4. Interactions between systems can result in changes in those systems.
5. Changes that occur as a result of interactions are constrained by conservation laws.
6. Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena.

Science Practices:

The student will…

- Use representations and models to communicate scientific phenomena and solve scientific problems.
- Use mathematics appropriately.
- Engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
- Plan and implement data collection strategies in relation to a particular scientific question.
- Perform data analysis and evaluation of evidence.
- Work with scientific explanations and theories.
- Connect and relate knowledge across various scales, concepts, and representations in and across domains.

Trigonometry Lessons

Khan Academy Trigonometry
YouTube.com
→ Search "Khan Academy"
→ Select "The Khan Academy"
→ Scroll & Select "Trigonometry"

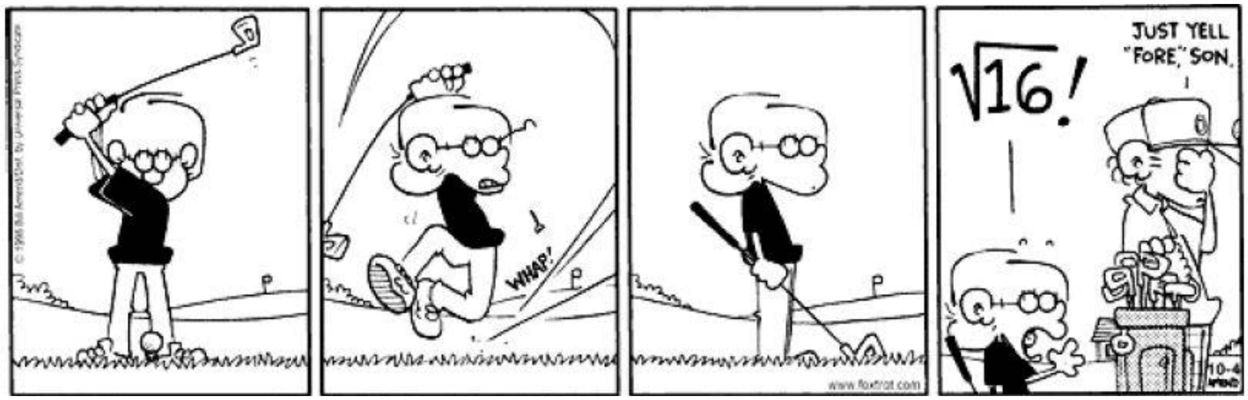
Or go directly here: [Khan Academy Trigonometry]

Below is a checklist for the recommended videos:

	Basic Trigonometry		Basic Trigonometry II		Radians and degrees
	Using Trig Functions		Using Trig Functions Part II		The unit circle definition of trigonometric function
	Unit Circle Definition of Trig Functions		Graph of the sine function		Graphs of trig functions
	Graphing trig functions		More trig graphs		Inverse Trig Functions: Arcsin
	Inverse Trig Functions: Arctan		Inverse Trig Functions: Arccos		

*We will use Pythagorean Theorem, SOH CAH TOA, & Inverse Trig Functions throughout the year.
*Most of our angle measures will be in degrees.

Math Review



Use available resources to solve each problem. Make sure to show your work by including at least one intermediate step between the original problem and your final answer. Please make your work neat – if you prefer to record work and answers on your own paper and attach those to the packet, please do. The assignment will be graded for both completion and accuracy – ½ point per question completed and ½ point per correct answer. The packet will be worth 50 points and will be due on the first day of class.

If you have questions over the summer, please email me at barry.mccaskill@littlerockchristian.com.

Part 1 – Solving Equations

Solve the following equations for the quantity indicated.

1. $y = \frac{1}{2}at^2$ Solve for *t.*

2. $x = v_o t + \frac{1}{2}at^2$ Solve for v_o.

3. $v = \sqrt{2ax}$ Solve for *x.*

4. $a = \frac{v_f - v_o}{t}$ Solve for *t.*

5. $a = \frac{v_f - v_o}{t}$ Solve for v_f.

6. $F = k\frac{m_1 m_2}{r^2}$ Solve for *r.*

7. $F = k\frac{m_1 m_2}{r^2}$ Solve for m_2.

8. $T = 2\pi\sqrt{\frac{L}{g}}$ Solve for *L.*

9. $T = 2\pi\sqrt{\frac{L}{g}}$ Solve for *g.*

10. $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ Solve for d_i.

11. $qV = \frac{1}{2}mv^2$ Solve for *v.*

Part 2 – Scientific Notation
Write the answer in scientific notation and simplify the units.

1. $T_s = 2\pi\sqrt{\frac{4.5x10^{-2}kg}{2.0x10^{3}kg/s^{2}}} =$

2. $K = \frac{1}{2}(6.6x10^{2}kg)(2.11x10^{4}\,m/s)^{2} =$

3. $F = 9x10^{-9}\,\frac{N{\cdot}m^{2}}{C^{2}}\left(\frac{(3.2x10^{-9}C)(9.6x10^{-9}C}{(0.32m)^{2}}\right) =$

4. $\frac{1}{R_p} = \frac{1}{4.5x10^{2}\Omega} + \frac{1}{9.4x10^{2}\Omega}$ $\qquad R_p =$

5. $e = \frac{(1.7x10^{3}J) - (3.3x10^{2}J)}{(1.7x10^{3}J)} =$

6. $(1.33)\sin 25.0° = (1.50)\sin\theta$ $\qquad \theta =$

7. $K_{max} = (6.63x10^{-34}J \cdot s)(7.09x10^{14}s^{-1}) - (2.17x10^{-19}J) =$

8. $\gamma = \frac{1}{\sqrt{1 - \frac{2.25x10^{8}m/s}{3.00x10^{8}m/s}}} =$

Part 3 – Dimensional Analysis for Converting Units
A very useful method of converting one unit to an equivalent unit is called the *dimensional analysis method* of unit conversion. You may be given the speed of an object as 25 *km/h* and wish to express it in *m/s.* To make this conversion, you must change *km* to *m* and *h* to *s* by multiplying by a series of factors so that the units you do not want will cancel out and the units you want will remain. Conversion: 1000 *m* = 1 *km* and 3600 *s* = 1 *h*

$$\left(\frac{25\ km}{h}\right)\left(\frac{1000\ m}{km}\right)\left(\frac{1\ h}{3600\ s}\right) =$$

1. What is the conversion factor to convert km/h to m/s?

2. What is the conversion factor to convert m/s to km/h?

Convert the following using dimensional analysis. Show all your work.

1. How many seconds are in a year?

2. Convert 28 km to cm.

3. Convert 45 kg to mg.

4. Convert 85 cm/min to m/s.

5. Convert the speed of light, $3x10^8$ m/s, to km/day

6. Convert 823 nm to m

7. $8.8x10^{-8}$ m to mm

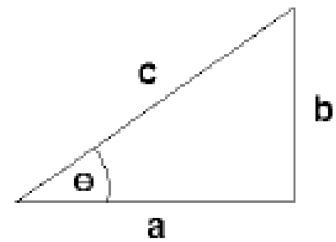
8. $1.5x10^{11}$ m to μm

9. 7.6 m^2 to cm^2

10. 8.5 cm^3 to m^3

Part 4 – Trigonometry and Basic Geometry
Solve for all sides and all angles for the following triangles. Your calculator must be in degree mode. Show all your work.

Example: $SOH\ \ CAH\ \ TOA$



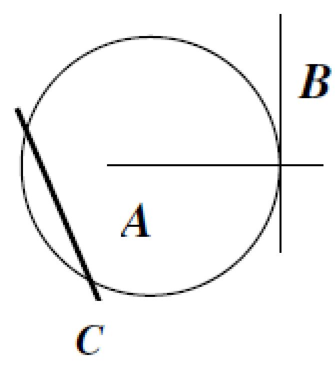
$$\sin\theta = \frac{opp}{hyp} \qquad \cos\theta = \frac{adj}{hyp} \qquad \tan\theta = \frac{opp}{adj}$$

1. θ = 55° and *c* = 32 m, solve for *a* and *b.*

2. θ = 45° and *a* = 15 m/s, solve for *b* and *c*.

3. *b*= 17.8 m and θ = 65°, solve for *a* and *c*.

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

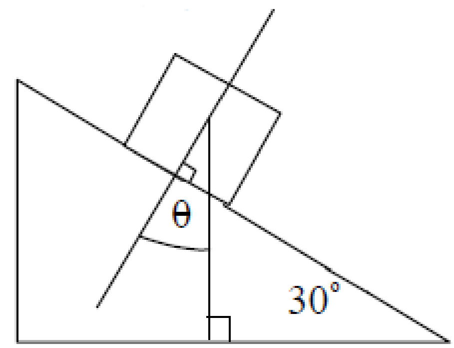


   a. What is line *B* in reference to the circle?

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

   c. What is line *C*?

5. What is the magnitude of θ?

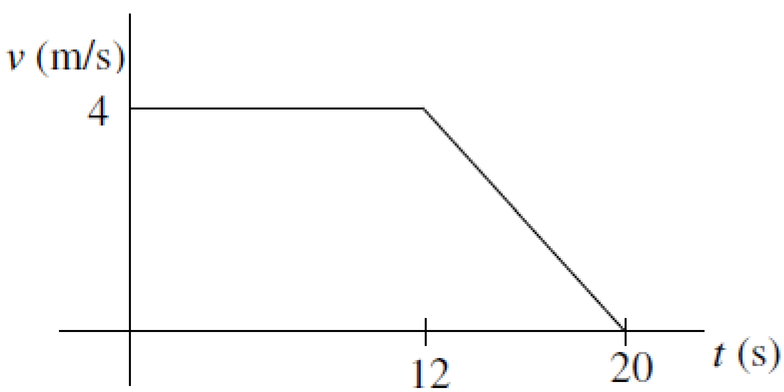


6. The radius of a circle is 5.5 cm.

   a. What is its circumference in meters?

   b. What is its area in square meters?

7. What is the area under the curve below?
   Include appropriate units.



Part 5 – Graphing Techniques
Frequently an investigation will involve finding out how changing one quantity affects the value of another. The quantity that is deliberately manipulated is called the *independent variable.* The quantity that changes as a result of the independent variable is called the *dependent variable.* The relationship between the independent and dependent variables may not be obvious from simply looking at the written data. However, if one quantity is plotted against the other, the resulting graph gives evidence of what sort of relationship, if any, exists between the variables.

When plotting a graph, take the following steps:

1. Identify the independent and dependent variables.

2. Choose your scale carefully. Make your graph as large as possible by spreading out the data on each axis. Let each space stand for a convenient amount. For example, choosing three spaces equal to ten is not convenient because each space does not divide evenly into ten. Choosing five spaces equal to ten would be better. Each axis must show the numbers you have chosen as your scale. However, to avoid a cluttered appearance, you do not need to number every space.

3. All graphs do not go through the origin (0,0). Think about your experiment and decide if the data would logically include a (0,0) point. For example, if a cart is at rest when you start the timer, then your graph of speed versus time would go through the origin. If the cart is already in motion when you start the timer, your graph will not go through the origin.

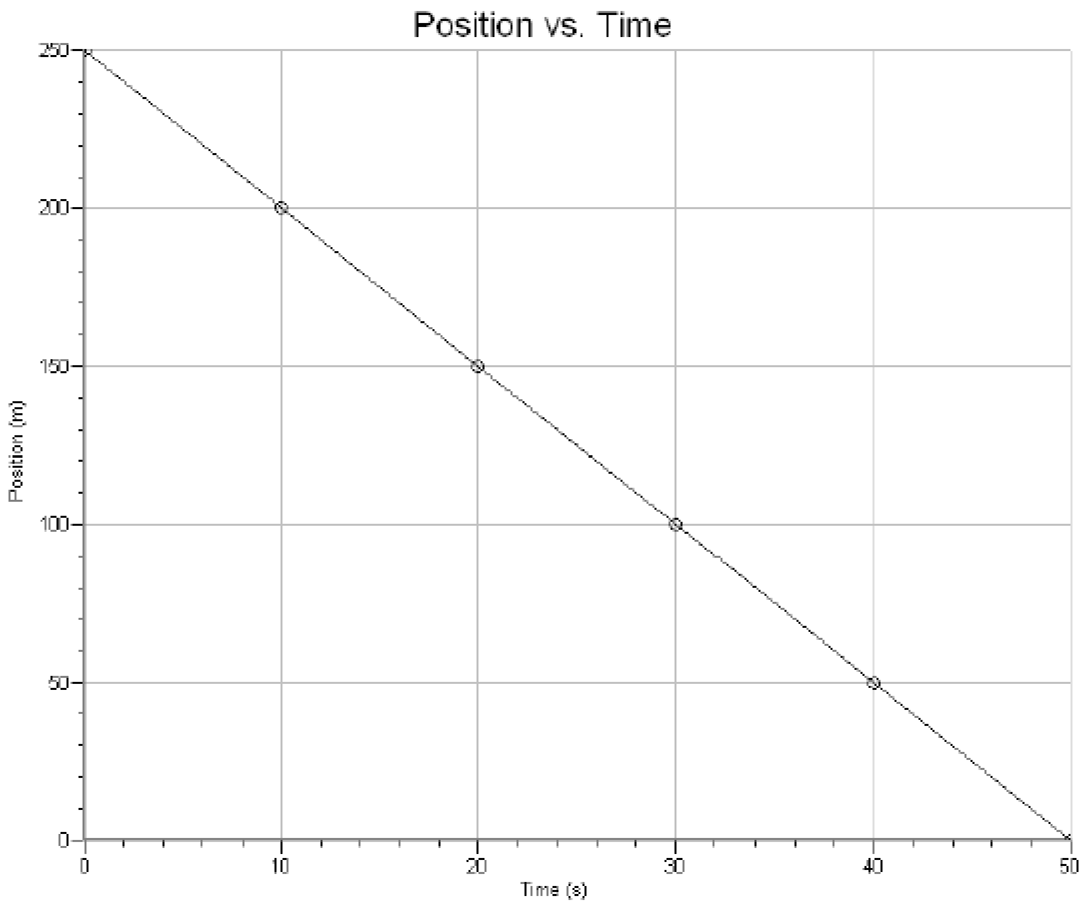
4. Plot the independent variable on the horizontal (x) axis and the dependent variable on the vertical (y) axis. Plot each data point. Darken the data points.

5. If the data points appear to lie roughly in a straight line, draw the best straight line you can with a ruler and a sharp pencil. Have the line go through as many points as possible with approximately the same number of points above the line as below. Never connect the dots. If the points do not form a straight line, draw the best smooth curve possible.

6. Title your graph. The title should dearly state the purpose of the graph and include the independent and dependent variables.

7. Label each axis with the name of the variable and the unit. Using a ruler, darken the lines representing each axis.

The graph shown on the next page was prepared using good graphing techniques. Go back and check each of the items mentioned above.



Graph the following sets of data using proper graphing techniques.
The first column refers to the x-axis and the second column to the y-axis.

1.

Pressure (torr)	**Volume (mL)**
100	800
200	400
400	200
600	133
700	114
800	100
1000	80

2.

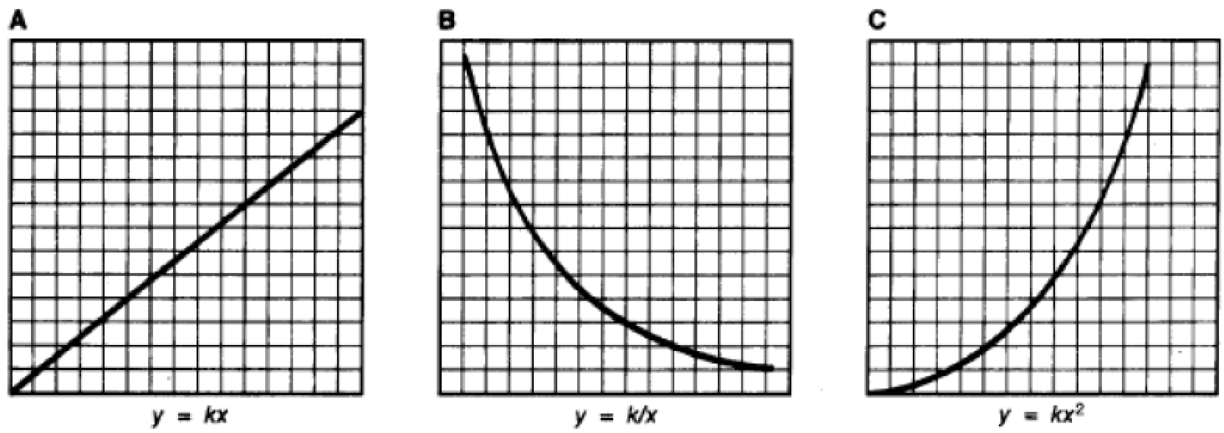
Time (s)	**Position (m)**
0	0
1	5
2	20
3	45
4	80
5	125

Time (s)	Speed (m/s)
0	0
1	20
2	45
3	60
4	84
5	105

Part 6 – Interpreting Graphs

In laboratory investigations, you generally control one variable and measure the effect it has on another variable while you hold all other factors constant. For example, you might vary the force on a cart and measure its acceleration while you keep the mass of the cart constant. After the data are collected, you then make a graph of acceleration versus force, using the techniques for good graphing. The graph gives you a better understanding of the relationship between the two variables.

There are three relationships that occur frequently in physics:



Graph A: If the dependent variable varies *directly* with the independent variable, the graph will be a *straight line*

Graph B: If *y* varies *inversely* with *x*, the graph will be a *hyperbola*.

Graph C. If *y* varies *directly with the square* of *x*, the graph is a *parabola.*

Reading from the graph between data points is called *interpolation.* Reading from the graph beyond the limits of your experimentally determined data points is called *extrapolation.* Extrapolation must be used with caution because you cannot be sure that the relationship between the variables remains the same beyond the limits of your investigation.

1. Suppose you recorded the following data during a study of the relationship of force and acceleration. Prepare a graph showing these data.

Acceleration (m/s^2)	**Force (N)**
6.0	10
12.5	20
19.0	30
25	40

   a. Describe the relationship between force and acceleration as shown by the graph.

   b. What is the slope of the graph? Remember to include units with your slope. (1 N: 1 kg·m/s^2)

   c. What physical quantity does the slope represent

   d. Write an equation for the line.

   e. What is the value of the force for an acceleration of 15 m/s^2?

   f. What is the acceleration when the force is 50.0 N?

2. The following data show the distance an object travels in certain time periods. Prepare a graph showing these data.

Position (m)	Time (s)
0	0
2	1
8	2
18	3
32	4
50	5

a. Describe the relationship between *x* and *y* and write a general equation for the curve.

b. Linearize the graph by plotting *d* vs. t^2. Complete the table with the values.

Position (m)	$Time^2$ (s^2)
0	0
2	
8	
18	
32	
50	

c. What is the slope of the graph? Remember to include units.

Part 7 – Experimental Error

When scientists measure a physical quantity, they do not expect the value they obtain to be exactly equal to the true value. Measurements can never be made with complete precision. Therefore, there is always some uncertainty in physical quantities determined by experimental observations. This uncertainty is known as *experimental error***.**

There are two kinds of errors: *systematic error* and *random error.* A systematic error is constant throughout a set of measurements. The results will be either always larger or always smaller than the exact reading. A random error is not constant. Unlike a systematic error, a random error can usually be detected by repeating the measurements.

Classify the following examples as systematic or random error.

1. A meter stick that is worn at one end is used to measure the height of a cylinder. _______

2. A clock used to time an experiment runs slow. _______

3. Two observers are timing a runner on a track. Observer A is momentarily distracted and so starts the stopwatch 0.5 s after Observer B. _______

4. Friction may cause the pointer on a balance to stick. _______

5. An observer reads the scale divisions on a beaker as one-tenths instead of one-hundredths. _______