AP Physics 1
Introduction information

Welcome to AP Physics 1. In this course you will find out how things work and why things work the way they do. Throughout the year, we'll cover some of the major areas of physics including: Kinematics, Newton's Laws of Motion, Gravitation & Circular Motion, Work, Energy & Power, Linear Momentum, Torque & Rotational Motion, Simple Harmonic Motion, and Waves & Sound,

In physics, we try to understand the relationships between the physical properties of objects and systems. We use mathematics to describe these relationships. So, while this course is not a math course, we do use math quite extensively. **It is extremely important to have a strong background in basic math and science skills to be successful in physics**; therefore, part 1 of this assignment will be to review the skills necessary for understanding the course material. You'll also need to organize and analyze data from lab investigations, which means **you must know how to graph**!

The Metric System

Everything in physics is measured using the metric system. The only time that you will see English units is when you convert them to metric units. The modern form of the metric system is called SI (from the French, "*Système International*").

In the SI system, all quantities are either base units or derived units. Derived units are made up of base units; therefore, you must be familiar with the SI base quantities and units – they will be your best friends by the end of the year!

SI Base Quantities and Units		
Quantity	**Unit**	**Unit Abbreviation**
length	meter	m
time	second	s
mass	kilogram	kg
electric current	ampere	A

In the metric system, a metric prefix is a prefix that precedes a basic unit of measure to indicate a multiple or fraction of the unit. Units are defined in multiples of ten from the standard unit. Here are the metric prefixes that we will use throughout the year. Again, to make your life much easier during the course, please become familiar with these common prefixes before we start the year. You must know these like the back of your hand during the course.

Metric (SI) Prefixes		
Prefix	**Abbreviation**	**Value**
nano-	n	10^{-9}
micro-	μ	10^{-6}
milli-	m	10^{-3}
centi-	c	10^{-2}
kilo-	k	10^{3}

Greek Letters

In physics, we use variables to denote a variety of unknowns and concepts. Many of these variables are letters of the Greek alphabet. If you are not familiar with these letters, you should become so. You need to have this exposure so that when class starts and you see " μ" on the board, you don't call it, "*that funny looking m-thing*". These variables have specific names and I will be using these names – you need to do the same.

Greek Letter	Name	Commonly Used For
α	alpha (lowercase)	angular acceleration
Δ	delta (uppercase)	showing a change in quantity
λ	lambda (lowercase)	wavelength
μ	mu (uppercase)	coefficient of friction
π	pi (uppercase)	mathematical constant
θ	theta (uppercase)	angle measures, angular displacement
ρ	rho (uppercase)	density, resistivity
Σ	sigma (uppercase)	showing the sum of numbers
τ	tau (uppercase)	torque
ω	omega (lowercase)	angular velocity
Ω	omega (uppercase)	unit for resistance

Other Symbols

There are a few mathematical symbols that we will use in physics formulas or to describe relationships between variables.

Other Symbols	Means
$\propto$	directly proportional to
$\parallel$	parallel
$\perp$	perpendicular

Review Part 1 - Basic Math and Science Skills for Physics

<u>Directions:</u> Answer each question below to the best of your ability. Please show your work in the space provided below each question and circle your final answers. Be sure to use units throughout your work and in final answers where necessary.

<u>Skill 1 - Solving Equations</u>

<u>You</u> will frequently need to manipulate an equation to solve for an unknown. Often the "givens" in AP Physics will not be numbers; rather they will be variables (letters). It is important that you know how to solve for any variable in an equation.

Example:

$$V_f = V_i + at^2$$

Solve the above equation above for t.

Answer: $t = \sqrt{\frac{V_f - V_i}{a}}$

Directions: Solve the following equations for the variables listed below:

1. Solve for $V2$. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

4. Solve for Δt. $\Delta X = V_i \cos\Theta \, \Delta t$

2. Solve for a. $y = V_o t + \frac{1}{2}at^2$

5. Solve for r. $F = k\frac{Q_A Q_B}{r^2}$

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

Skill 2 - Describing Relationships

It is important that you understand what an equation **physically** means in this course. Therefore, you must be able to describe the relationships between given variables in a formula.

Example:

$$a_c = \frac{v^2}{r}$$

In the above equation, ac equals the centripetal acceleration of an object moving in a circle with radius of ***r*** and moving around a circle with a tangential velocity of ***v***.

(a) In the equation above, what is the relationship between centripetal acceleration and tangential velocity?

Answer: The centripetal acceleration of the object is directly proportional to the square of the object's tangential velocity. This means that the centripetal acceleration will increase as the tangential velocity increases.

(b) In the equation above, what is the relationship between centripetal acceleration and the radius of the circular path in which the object is traveling?

Answer: The centripetal acceleration of the object is inversely proportional to the radius of the circular path in which the object is traveling. This means that the centripetal acceleration will increase as the tangential velocity decreases.

Use the following for question:

In the equation at the right, g equals gravitation fi
G is the Newtonian of gravity. M is the mass and
the radius.

$$g = G\,\frac{M}{r^2}$$

1. What will be the change in the gravitational field if the mass is doubled and the radius is tripled

Skill 3 – Dimensional Analysis

It is important that you understand how to convert from one unit to another using conversion factors. You must know metric prefixes in order to do this.

Example:

> Ex. How many centimeters are in 0.098 kilometers?
>
> *Answer:*
>
> 100 cm = 1 m
>
> 1 km = 1000 m
>
> $$\frac{0.098\ \cancel{km}}{1} \times \frac{1000\ \cancel{m}}{1\cancel{km}} \times \frac{100cm}{1\cancel{m}} = 9800cm$$

1. How many seconds are in 28 hours?

2. How many kiloliters are in 12,500 mL?

3. Convert 45 km/hr to m/s.

Skill 4 - Scientific Notation

Scientific Notation - Part A: There are things in physics that are very, very large (like the mass of a planet in kilograms, for example) or very, very small (like the mass of an electron in kilograms, for example). You must be able to recognize that a number is in scientific notation and know how to deal with it.

4. The following numbers are in scientific notation. Express them in standard notation.

   A. 6.370×10^{4} mg

   B. 4.2×10^{-2} m

5. The following numbers are in standard notation. Express them in proper scientific notation

   A. 0.0000015 g

   B. 763,420,000 cm

Scientific Notation - Part B: You will be required to use scientific notation in calculations.

1. $K = \frac{1}{2}(6.6 \times 10^2 \text{ kg})(2.11 \times 10^4 \text{ m/s})^2$

2. $F = 9x10^{-9}\ \frac{N\,m^2}{C^2}\ \left(\frac{(3.2x10^{-9}C)(9.6\,x\,10^{-9}C)}{(0.32m)^2}\right)$

3. $(9.0 \times 10^7\text{m}) / (3.0 \times 10^3\text{s})$

4. $T_s = 2\pi\sqrt{\frac{4.5\,x\,10^{-2}Kg}{2.0\,x\,10^3\ kg/s^2}}$

Skill 5 - Significant Figures

Significant Figures - Part A: You must know what significant figures are and how to determine the number of significant figures in a measurement. I have included the rules for determining the number of sig figs in a measurement below in case you have not encountered this in any of your math or science classes

What are significant figures?

In scientific work, all numbers are assumed to be derived from measurements and, therefore, the last digit in each number is uncertain. All certain digits plus the first uncertain digit are significant figures. Only numbers determined by definition or by counting are exact. Numbers determined by definition or counting are said to have an infinite number of significant figures

Four Rules for Determining the Number of Sig Figs in a Measurement:

1. **Nonzero digits are always significant.** *(Ex. There are 3 sig figs in 568 cm and 2 sig figs in 1.4 seconds.)*
2. **All final zeros after a decimal point are significant.** *(Ex. There are 4 sig figs in 2.300 sec.)*
3. **Zeros between two other significant digits are always significant.** *(Ex. There are 3 sig figs in 203 m/s and 4 sig figs in 2.002 cm.)*
4. **Zeros solely used a placeholders are NOT significant.** *(Ex. There are 2 sig figs in 26,000 grams and only 1 sig fig in 0.000005 km)*

State the number of significant figures in each measurement:

1. 1405 kg _____
2. 0.0034 m _____
3. 5.80×10^6 kg _____

Significant Figures - Part B: You must know how to determine the number of significant figures that should be in your answer.

Rules for Determining the Number of Sig Figs in an Answer When Adding and/or Subtracting:

1. Determine the **precision** of each measurement. (Precision means how many places after the decimal for each measurement. Ex. 1.0 = one decimal place, 1.12 = two decimal places)
2. Make a note of the lowest number of decimal places. This is the least precise measurement.
3. Now add or subtract the measurements.
4. Round your answer so that it matches the precision of the measurement with the lowest number of decimal places.

Ex.
Add 1.02 s + 0.0003 s + 26.022 s = ?

1.02 has 2 decimal places

0.0003 has 4 decimal places

26.022 has 3 decimal places

So, 1.02 s is the least precise with only two decimal places - our answer must match this.

Add to find the answer:

1.02 s + 0.0003 s + 26.022 s = *27.0423 s*

Round to two decimal places:

So, our answer with the correct amount of sig figs is ***27.04 s***

Rules for Determining the Number of Sig Figs in an Answer When Multiplying and/or Dividing:

1. Determine the **# of sig figs** in each measurement. (Use the rules above.)
2. Make a note of the lowest number of sig figs.
3. Now multiply or divide the measurements.
4. Round your answer so that it has the same number of sig figs as the measurement with the least amount.

Ex.
Multiply 1.02 m x 0.0003 m x 26.022 m = ?

1.02 has 3 sig figs

0.0003 has 1 sig fig

26.022 has 5 sig figs

Note the lowest amount of sig figs: 1 sig fig

Multiply to find the answer:

1.02 m x 0.0003 m x 26.022 m = *0.007962732 m3*

Round so that the answer only has 1 sig fig:

So, our answer with the correct amount of sig figs is

0.008 m^3

Perform the following operations. Use the correct number of significant figures in your answers.

1. 82.5 cm + 23.59 cm =
2. 80 cm + 145.88 cm + 121 cm =
3. 13.89 m – 6.8932 m =
4. 133 L – 6.45 L =
5. 3000 kg + 12.24 kg + .998 kg =
6. 32.88 m^2 / 4.41 m =
7. 0.045 g / 0.900 ml =
8. 2.005 cm x 5.0 cm =
9. 2.5 mm x 1.338 mm =
10. 120 km^3 / 8.56 km^2 =

Skill 6 – Trigonometry

Write the formulas for each one of the following trigonometric functions: Remember SOHCAHOTA

Sin Θ = Cos Θ= Tan Θ =

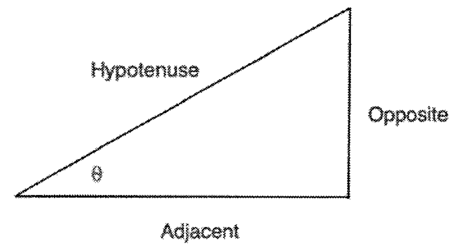
Calculate the following unknowns using trigonometry. Use a calculator, but show all your work. (Make sure your calculator is in DEGREES mode.) Please include appropriate units with all answers

1.

Adjacent = ?
Opposite = ?
Hypotenuse = 12 m
Θ = 30.0°

2.

Adjacent = ?
Opposite = ?
Hypotenuse = 59.3 m
Θ = 60.0°



3.

Adjacent = 2.3 m
Opposite = 1.4 m
Hypotenuse = ?
Θ = ? °

4.

Adjacent = 39.8m
Opposite = 17 m
Hypotenuse = ?
Θ = °

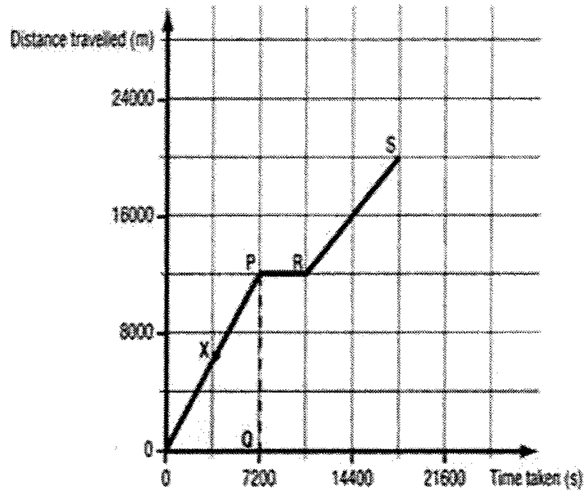
5.

Adjacent = 4.3 m
Opposite = 15.1 m
Hypotenuse = ?
Θ = ?°

Skill 1 – Reading Graphs

You must be able to pull out and explain information about data from an experiment just by looking at a graph of this data. This will include recognizing relationships and trends in the data.

Graph 1: Distance a Person Walked vs. Time



1. What is the independent variable for this graph? What units are used to measure this quantity?
   ____

2. What is the dependent variable for this graph? What units are used to measure this quantity?
   ____

3. At what position did the person start? ______________________________

4. What was the position of the person at 2 hours? ______________________________

5. What was the position of the person at 4.5 hours? ______________________________

6. Approximately, at what time (in seconds) did the person reach 4,000 meters?
   ____

7. Approximately, at what time (in seconds) did the person reach 14,000 meters?
   ____

8. At what time, in seconds, did the person reach its maximum position?
   ____

9. Describe the motion of the person from point P to point R. How long (in hours) did they do this for?

10. Rank the **speed** of the person during the following intervals (1 = least, 3 = greatest). Explain how you determined this.

    _____ from X to P _____ from P to R _____ from R to S

Skill 2 – Constructing Graphs (Graphing Data)

Graphs are useful tools in physics because trends in data and relationships between variables are easy to visualize when represented graphically. Now, instead of just reading a graph, you must also create your own before analyzing the data. Review the steps below for making graphs in science to be sure you have included all of the necessary components.

Following the steps below will help you to make certain that all components of the graph are correctly presented.

1. **Identify the variables.** Independent on the x-axis and dependent on the y-axis
2. **Determine the range.** What is the highest value data point for each axis?
3. **Select the scale units.** Divide each axis uniformly into appropriate units using the maximum amount of space available.

   (Remember that the axes may be divided differently but each square along the same axis must represent the same interval.)
4. **Number and label each axis.** Be sure to include units where appropriate as part of the axis label.
5. **Plot the data points** as ordered pairs. (x,y)
6. **Draw the best fit line (may be a straight line or a smooth curve).** For a straight line, eyeball it. “Eyeball it” means: use a straight edge to draw your line in such a way that approximately the same number of points lie above and below the line.
7. **Title the graph.** The title should clearly describe the information contained in the graph. It is common to mention the

   dependent variable (y-axis) first followed by the independent variable (x-axis).

Sample Data Set A:

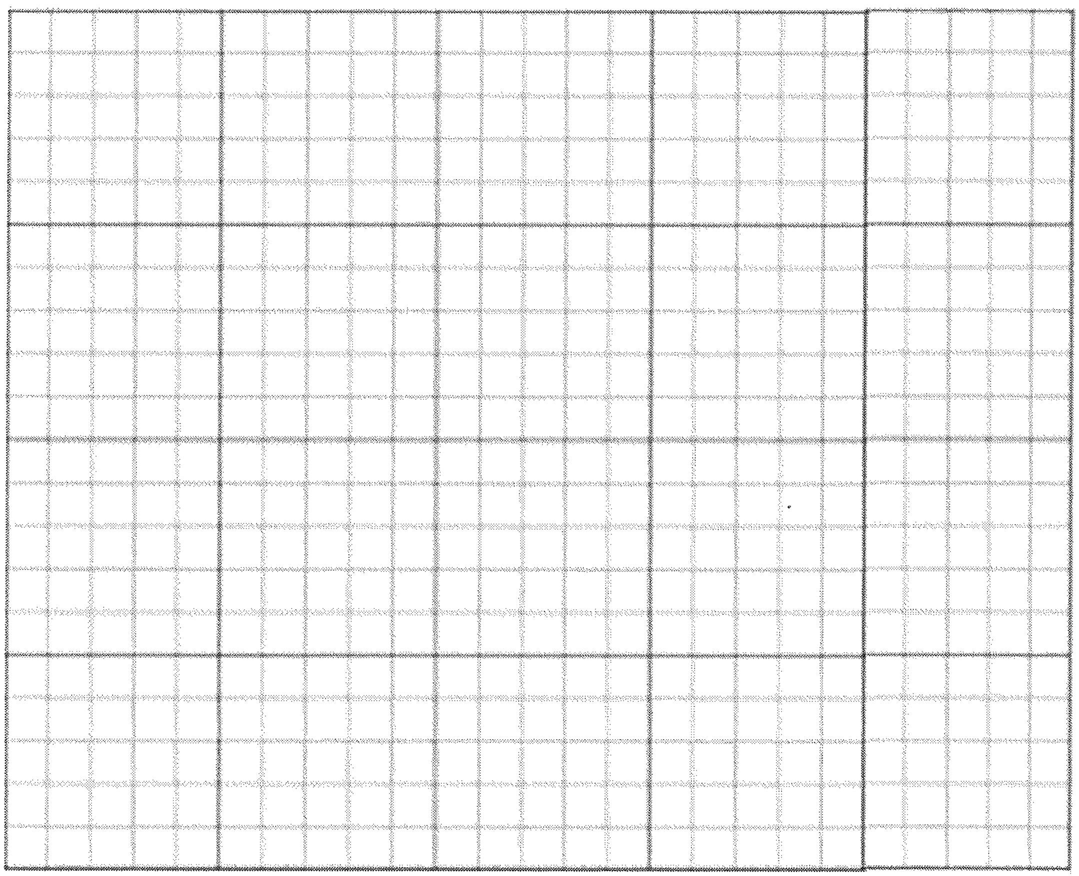
The following set of data was collected while experimenting with position and time of a miniature motorized car traveling on a straight track. Plot the data below on the grid. After plotting the graph for the data set, use the graph to answer the analysis questions in Skill 3.

Time (mins)	Position (m)
0	0
5	18
10	32
15	45
20	58
25	74

Sample Data Set B:

The following set of data was collected during an experiment to find the density for an unknown pure metal. Five different volumes of the same unknown pure metal were massed and the data was recorded below. After plotting the graph for the data set, use the graph to answer the analysis questions in Skill 3.

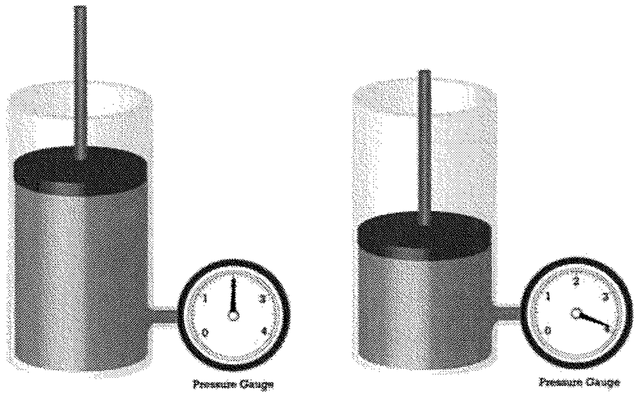
Volume (cm3)	Mass (g)
0.18	2.00
0.44	5.00
0.66	7.50
1.41	16.00
2.11	24.00



Sample Data Set C:

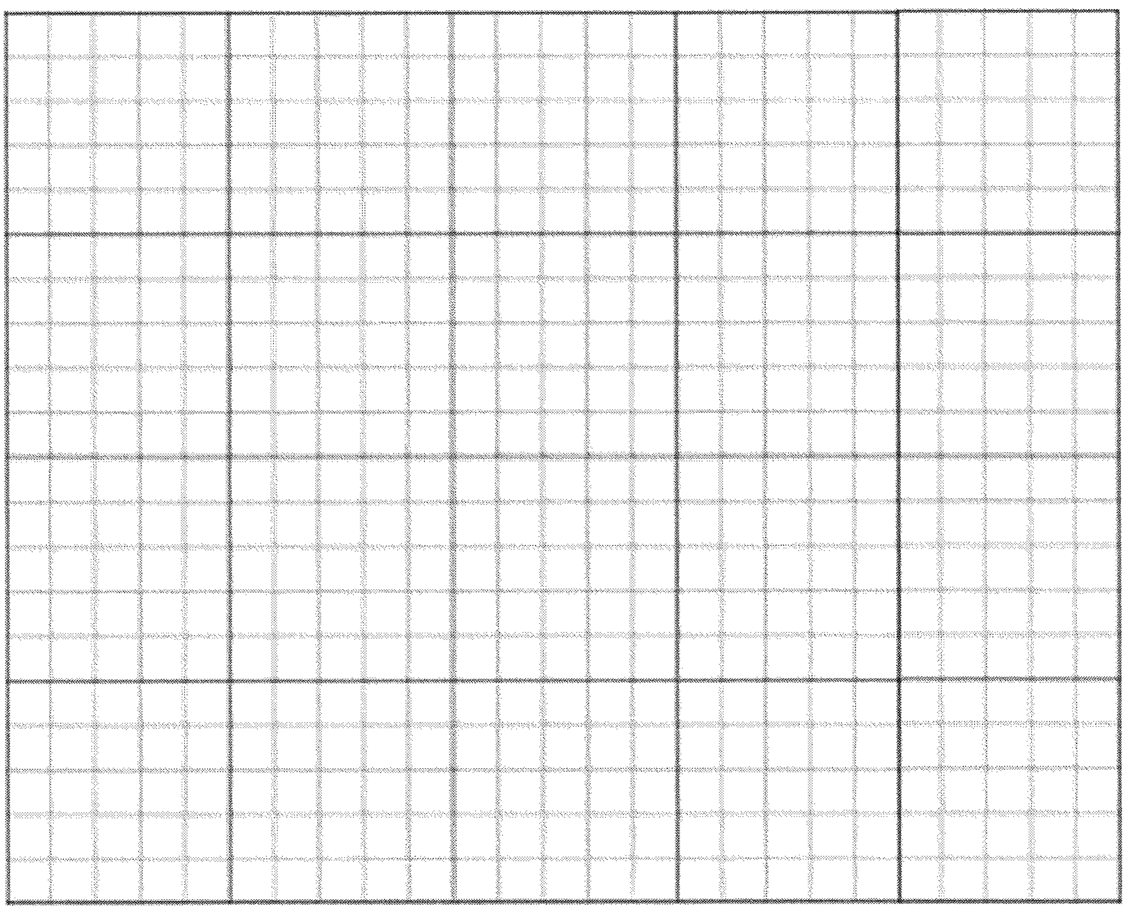
The following set of data was collected during an experiment where an amount of a confined gas is being compressed by a moveable piston pressing downwards on the gas, which exerts pressure on the gas. (See diagram of lab apparatus below.) A known pressure is exerted using the moveable piston and the volume of the confined gas was then measured and recorded in the table below. After plotting the graph for the data set, use the graph to answer the analysis questions in Skill 3.

Apparatus for Pressure and Volume Lab:



Data for Pressure and Volume Lab:

Volume (mL)	Pressure (Pa)
22, 400	1.0
11, 200	2.0
5, 600	4.0
2, 800	8.0
1, 400	16.0



Skill 3 – Analyzing Graphs

You must be able to use the graph to analyze data from an experiment. This includes predicting relationships, or using the slope, x and y-intercepts, and/or the area under the curve to tell you physical information about an experiment or relationship. This may also include interpolation or extrapolation. (P.S. Be sure you know when it is appropriate to use interpolation or extrapolation.)

Analysis Questions:

Directions: *Use your graph from* ***Sample Data Set A*** *for Questions 1-5.*

1. What is the independent variable for this graph? ...the dependent variable? Explain.

2. Determine the position of the car after 2.5 minutes.

3. Is there a relationship between the variables on the x and y-axis? If so, what type of relationship is this? How do you know this?

4. Calculate the slope of the best fit line. (DO NOT USE ORIGINAL DATA POINTS UNLESS THEY LIE ON YOUR DRAWN IN BEST FIT LINE.) Show your work below

5. If the experiment were carried out for 30 minutes, and the motion of the car remained as it was before, what would be the position of the car at this time?

Directions: *Use your graph from* ***Sample Data Set B*** *for Questions 6-11.*

6. What is the relationship between volume and mass in this experiment? How can you tell?

7. What does a data point on this graph actually represent?

8. The **slope** of the best fit line of this graph is equal to the **density** of the unknown pure metal. Explain why this is true using the definition of slope, the definition (or formula) for density, and your graph.

10. What volume would a 10.00 gram sample of this substance occupy? What did you do to determine this?

11. How could you determine the identity of unknown pure metal

*<u>Directions:</u> Use your graph from **Sample Data Set C** for Questions 12-16.*

12. . Identify the independent and dependent variables in this graph. Explain.

13. Does this graph represent a linear relationship? Why or why not?

14. If you decided that this graph does not show a linear relationship, what type of relationship do you think it shows? Explain.

15. If the pressure on the confined gas is decreased over a period of time, what trend in volume could be expected? How do you know this in terms of the relationship you chose in #13/14?

16. If the pressure on the confined gas is increased over a period of time, what trend in volume could be expected?