Name: ______________________________

AP Physics Summer Assignment 2020

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Due Date: Week two of school. Summer Assignment Quiz – third week of school.

Introduction: The purpose of AP physics I is to provide students with the equivalent of a calculus-based first semester college course in physics (called Mechanics.) The calculus needs of this course will be taught as they arise in class. This is a demanding course that requires a level of abstract thinking and facility with problem-solving that goes beyond the experience of most students prior to taking the course. The course content is cumulative, and our goal is for you to get a '5' on the AP physics C – Mechanics test.

Course requirements:

1) A scientific graphing calculator
2) A dedicated bound laboratory notebook for all data collection, analysis, storing printed graphs, postlab discussion notes and conclusions.
3) A desire to learn, and a willingness to overcome self-doubt when the material seems too hard to learn. Trust us, you can do it; it just takes time and hard work.

Summer Assignment:

25 pts for Summer work (checked the second week of school)

50 pts for a Summer Assignment Quiz on the third week of school.

For the quiz, know -

- A modern definition of force – may require some research on your part
- The four fundamental forces and their relative strengths
- Be able to convert between unit prefixes - lengths (e.g. millimeters to kilometers), times (e.g. milliseconds to seconds, years to seconds), masses (e.g. milligrams to kilograms).
- Recognize and name symbols from the Greek alphabet.
  What does $\Phi\ \iota\ \sigma\ \iota\ \kappa\ \alpha$ spell?

Definitions:

Mass	Scalar	Position & displacement
Weight	Vector	Instantaneous velocity
Mass Density	Unit Vector	Avg. velocity & speed
	Vector component	Acceleration

Formulas:

Circumference and area of a circle
Surface area and volume of a sphere
Surface area and volume of a cylinder

Trigonometry and Vectors:

Finding the components of a vector (and $\hat{\boldsymbol{i}}, \hat{\boldsymbol{j}}, \hat{\boldsymbol{k}}$ notation)- good Khan Academy Video
https://www.khanacademy.org/math/precalculus/x9e81a4f98389efdf:vectors/x9e81a4f98389efdf:unit-vec/v/intro-unit-vector-notation

Graphical and component addition and subtraction of vectors

Mathematical modeling

Finding the equations of curves from the following six functions:

linear, quadratic, square root, inverse, constant, inverse square

(See the attached handout for a discussion on linearizing graphs to find equations.) Using r-values is *not* sufficient to prove that data fits the curve.

Ratio reasoning

Assigned problems:

HRW Serway Book (pdf of the chapters accompanies the assignment)

pp 17-18 -- problems 3, 6, 7, 9, 11, 12, 13, 15, 20, 21, and 22
pp 64-65 - problems 7 -25 odd

Unit I Worksheet I: *Graphing Practice* (contained in this packet.)

Be sure to include proper graphs (computer or graph paper) to show work.

Ratio Reasoning Worksheet (contained in this packet.)

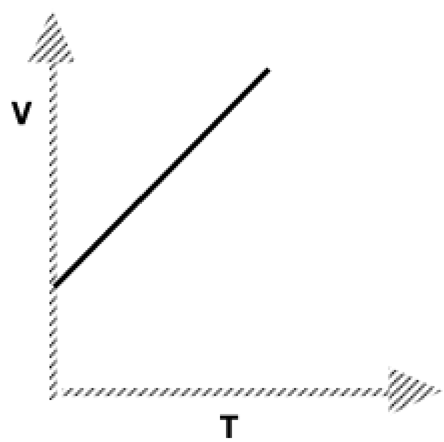
Unit I Reading – Graphical Methods

One of the most effective tools for the visual evaluation of data is a graph. The investigator is usually interested in a quantitative graph that shows the relationship between two variables in the form of a curve.

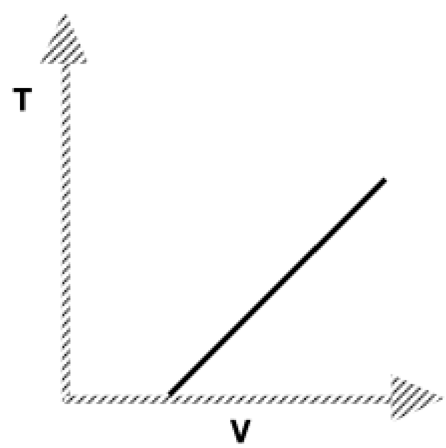
For the relationship y = f(x), **x** is the *independent variable* and **y** is the *dependent variable*. The rectangular coordinate system is convenient for graphing data, with the values of the dependent variable y being plotted along the *vertical axis* and the values of the independent variable x plotted along the *horizontal axis*.

Positive values of the dependent variable are traditionally plotted above the origin and positive values of the independent variables to the right of the origin. This convention is not always adhered to in physics, and thus the positive direction along the axes will be *indicated by the direction the arrow heads point.*

The choice of dependent and independent variables is determined by the experimental approach or the character of the data. Generally, the **independent variable** is the one over which the *experimenter has complete control*; the **dependent variable** is the one that *responds to changes* in the independent variable. An example of this choice might be as follows. In an experiment where a given amount of gas expands when heated at a constant pressure, the relationship between these variables, V and T, may be graphically represented as follows:



Correct



Incorrect

By established convention it is proper to plot V = f (T) rather than T = f (V), since the experimenter can directly control the temperature of the gas, but the volume can only be changed by changing the temperature.

Curve Fitting

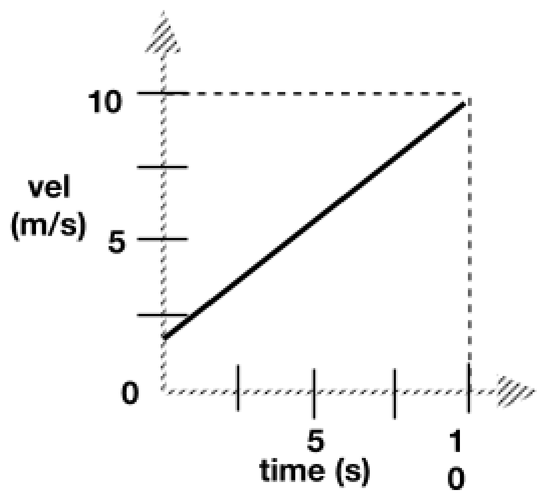
When checking a law or determining a functional relationship, there is good reason to believe that a uniform curve or straight line will result. The process of matching an equation to a curve is called **curve fitting**. The desired empirical formula, assuming good data, can usually be determined by inspection. There are other mathematical methods of curve fitting, however they are very complex and will not be considered here. Curve fitting by inspection requires an assumption that the curve represents a linear or simple power function.

If data plotted on rectangular coordinates yields a straight line, the function y = f(x) is said to be *linear* and the line on the graph could be represented algebraically by the slope-intercept form:

$$y = mx + b,$$

where **m** is the slope and **b** is y-intercept.

Consider the following graph of velocity vs. time:



The curve is a straight line, indicating that v = f(t) is a linear relationship. Therefore,

$$\mathbf{v} = m\mathbf{t} + b,$$

where slope = m = =

From the graph,

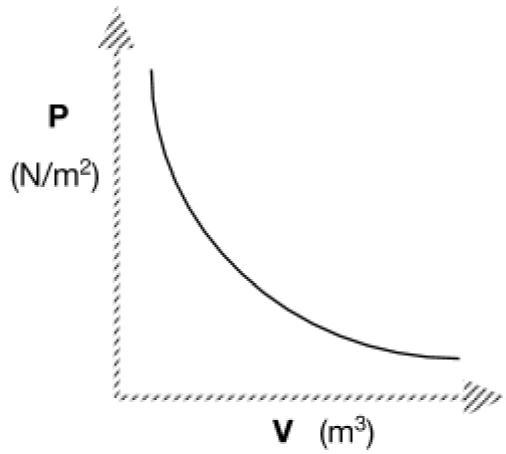
m = = 0.80 m/s.

The curve intercepts the v-axis at v = 2.0 m/s. This indicates that the velocity was 2.0 m/s when the first measurement was taken; that is, when t = 0. Thus, b = v_0 = 2.0 m/s.

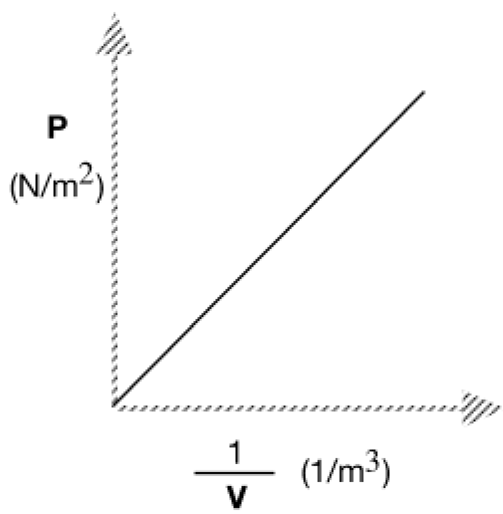
The general equation, **v** = m**t** + b, can then be rewritten as

$$\mathbf{v} = (0.80\ \text{m/s})\mathbf{t} + 2.0\ \text{m/s}.$$

Consider the following graph of pressure vs. volume:



The curve appears to be a hyperbola (inverse function). Hyperbolic or inverse functions suggest a test plot be made of P vs . The resulting graph is shown below:

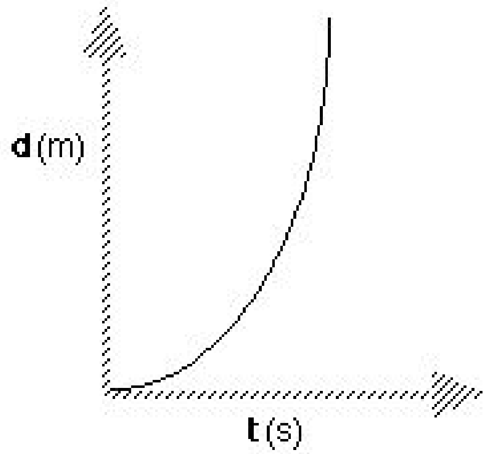


The equation for this straight line is:

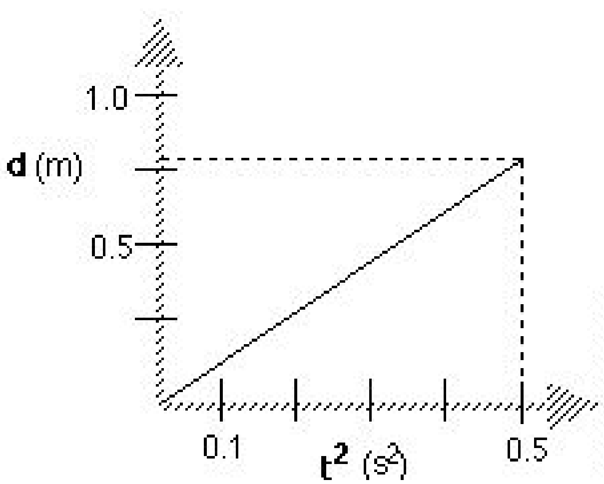
P = m () + b,

where b = 0. Therefore; P = ; when rearranged, this yields PV = constant, which is known as Boyle's law.

Consider the following graph of distance vs. time:



The curve appears to be a top-opening parabola. This function suggests that a test plot be made of d vs. t^2. The resulting graph is shown below:



Since the plot of d vs. t^2 is linear,

$\mathbf{d} = m\mathbf{t}^2 + b$.

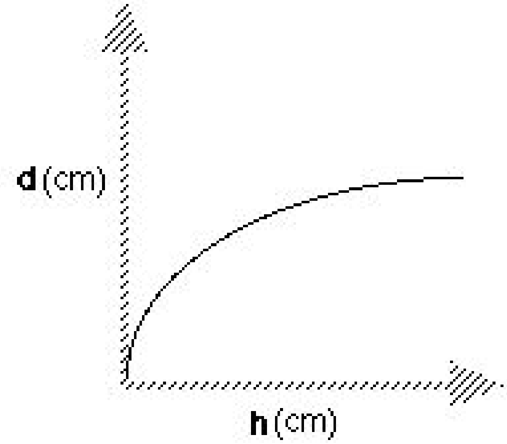
The slope, m, is calculated by

$$m = \frac{.80\text{m}}{.50\text{s}^2} = 1.6 \text{ m/s}$$

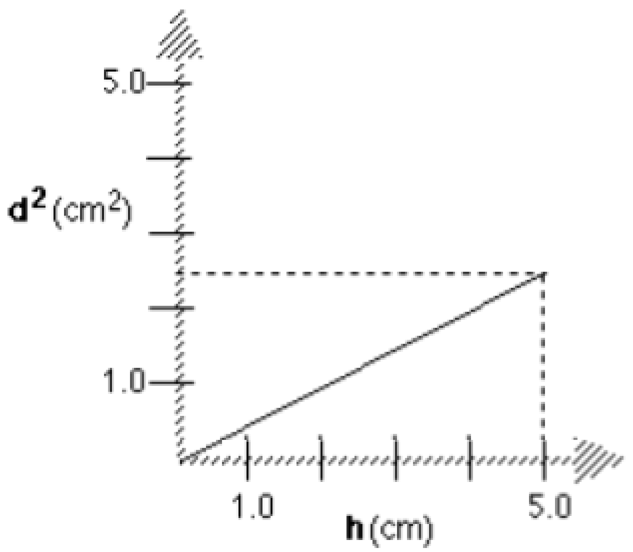
Since the curve passes through the origin, b = 0. The mathematical expression that describes the motion of the object is

$\mathbf{d} = (1.6 \text{ m/s}^2)\mathbf{t}$.

Consider the following graph of distance vs. height:



The curve appears to be a side-opening parabola. This function suggests that a test plot be made of d^2 vs. h. The resulting graph is shown on the following page.



Since the graph of d^2 vs. h is linear the expression is

$$\mathbf{d}^2 = m\mathbf{h} + b.$$

The slope, m, is calculated by

m =

=

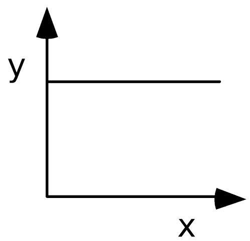
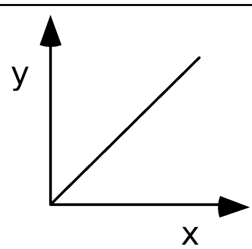
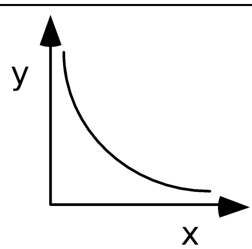
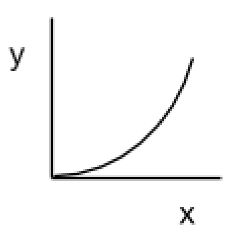
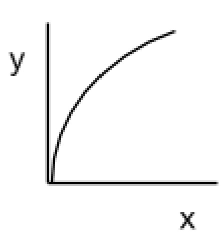
= 0.50 cm.

Since the curve passes through the origin, b = 0. The mathematical expression is then

$$\mathbf{d}^2 = (0.50 \text{ cm})\mathbf{h}.$$

Graphical Methods-Summary

A graph is one of the most effective representations of the relationship between two variables. The independent variable (one controlled by the experimenter) is usually placed on the x-axis. The dependent variable (one that responds to changes in the independent variable) is usually placed on the y-axis. It is important for you to be able interpret a graphical relationship and express it in a written statement and by means of an algebraic expression.

Graph shape	Written relationship	Modification required to linearize graph	Algebraic representation
	As x increases, y remains the same. There is no relationship between the variables.	None	$y = b$, or y is constant
	As x increases, y increases proportionally. Y is directly proportional to x.	None	$y = mx + b$
	As x increases, y decreases. Y is inversely proportional to x.	Graph y vs $\frac{1}{x}$, or y vs x^{-1}	$y = m\left(\frac{1}{x}\right) + b$
	Y is proportional to the square of x.	Graph y vs x^2	$y = mx^2 + b$
	The square of y is proportional to x.	Graph y^2 vs x	$y^2 = mx + b$

When you state the relationship, tell how y depends on x (e.g., as x increases, y ….)

Name

UNIT I Worksheet 1: GRAPHING PRACTICE

For each data set below, determine the mathematical expression. To do this, **first graph (on graph paper or computer)** the original data. Assume the 1st column in each set of values to be the **independent** variable and the 2nd column the **dependent** variable. Then taking clues from the shape of the first graph, modify the data so **and graph the new data set so** that the modified data will plot as a straight line. Using the slope and y-**intercept** from the linear fit, write an appropriate mathematical expression for the relationship between the variables. Be sure to include units on the slope and intercept!

Data set 1

V (m^3)	**P** (pa)
.1	40
.5	8
1	4
2	2
4	1
5	.8
8	.5
10	.4

Mathematical expression #1

Data set 2

t (s)	**x** (m)
.1	.03
.2	.12
.5	.75
1	3
2	12
3	27
4	48
5	75

Mathematical expression #2

Data set 3

A (months)	**W** (lbs)
1	7.3
2	9.4
3	10.5
4	12.0
5	13.0
6	14.3
7	15.2
8	16.7

Mathematical expression #3

Data set 4

t (s)	**v** (m/s)
.3	10
1.2	20
2.7	30
4.8	40
7.5	50
10.8	60
14.7	70
19.2	80

Mathematical expression #4

Ratio reasoning word problems:

1. A wheat field has dimensions L by W. If a farmer can double both sides, by what factor does the area increase? By what factor does the perimeter increase?

2. An extra large pizza has an area that is 21% greater than the large sized pie. How much larger is the diameter of the extra large than the large?

3. The drag force on a smooth spherical ball can be modeled by the expression:

$$D = \frac{1}{2} C \rho A v^2$$

Where C is the drag coefficient, ρ is the density of air, A is the cross-sectional area of the sphere and v is the speed of the sphere. By what factor would each of the following change the drag force?

a. Doubling the speed ________

b. Doubling the density ________

c. Doubling the diameter of the sphere and also halving the speed ________

d. Two spheres are moving through air at different speeds but experience the same drag force. If ball A is moving at twice the speed of ball B, what can you conclude about the cross-sectional area of ball B compared to that of A?

4. Kepler's third law for planetary motion relates the period of orbit T (in years) of a planet to its mean distance R (in km) from the sun. It states:

$$R^3 = k\, T^2$$

a. What are the correct units for the constant k?

b. If planet A is at a distance R from a star, with a period T of 20 years, what will be the orbital period of planet B which is located twice as far away from the same star?