AP PHYSICS 1

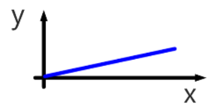
Name:

W-1/Summer Work

This will give you an idea of the math background that is expected. Doing the work will better help you navigate the concepts of physics. Although it is not graded homework, doing this work is <u>essential</u> for your success in this course. If you have any questions, you may contact me: santosh.madhavan@ocps.net.

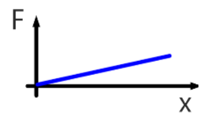
LINEAR GRAPHS

The equation for a straight line that passes through the origin is $y = mx$, where m is the slope of the graph.

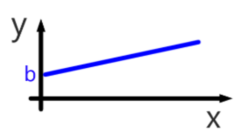


Whenever we get a graph like this, we say "**y is proportional to x**," which means that if you double x, y also doubles; if you triple x, y becomes three times as much. Mathematically, you would write $\mathbf{y \propto x}$. the symbol $\propto$ just means "proportional to."

If, instead of y and x, the graph had some other variable, like the one below, we would still apply the same idea: $F \propto x$.



Both of the graphs above are said to be straight-line or linear graphs. In these graphs, when $x = 0$, y (or F) becomes 0 as well. In some linear graphs, that's not true. We say these lines have an intercept.

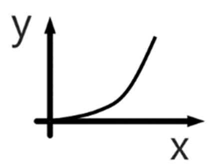


The above line hits or intercepts the y-axis. The equation becomes $y = mx + b$, where b is the point on the y-axis when $x = 0$. We **<u>can no longer say</u>** that $y \propto x$: y does **not** double when x doubles.

LINEARIZATION OF GRAPHS

EXAMPLE 1

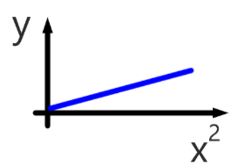
If a graph is plotted for the equation, $y = 2x^2$, the line would not be linear.



To linearize this graph, we compare the equation to the one for a straight line.

$$y = m x$$
$$y = 2 x^2$$

Notice that x^2 takes the place of x in the general equation for a straight line; 2 takes the place of m. Now, if we plot y along the y-axis and x^2 along the x-axis we'll get a straight line with a slope of 2.

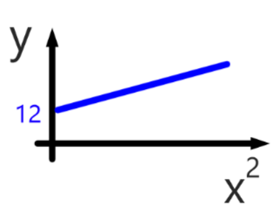


EXAMPLE 2

To linearize the graph for the following equation, $y = 3x^2 + 12$, as before, write the general equation for a straight line and compare it to the equation that is being linearized.

$$y = m x + b$$
$$y = 3 x^2 + 12$$

Comparing the two equations, x^2 takes the place of x in the general equation.



The slope of this line is 3 and the y-intercept is 12.

EXAMPLE 3

Linearize the following equation where ℓ and T are variables. ℓ is the independent variable (which is always graphed along the x-axis) and g is the acceleration due to gravity.

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

First, we'll have to transform the equation to match the requirement for ℓ to be along the x-axis. Squaring both sides:

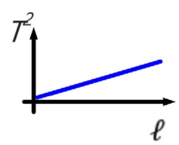
$$T^2 = \frac{4\pi^2}{g}\,\ell$$

Comparing the equation to the general equation for a straight line,

$$y = m\,x + b$$

$$T^2 = \frac{4\pi^2}{g}\,\ell$$

we see that the line will have no intercept with T^2 along the y-axis and ℓ along the x-axis. The slope of the line will be $4\pi^2/g$.



If you're asked to calculate g, slope $= \frac{4\pi^2}{g}$, $g = \frac{4\pi^2}{slope}$

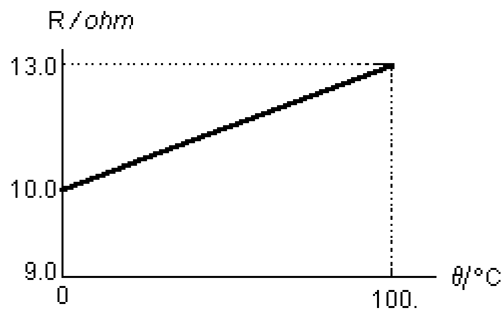
EXERCISE

Do the following exercises **on a separate sheet of paper**. The graphs may be drawn on a graph paper or by using Excel. In either case, the graph should be titled and the axes labeled with units.

1. The following equation represents the variation of resistance, R, with temperature, θ.

$$R = R_O + \alpha\,\theta$$

R_O and α are constants. A graph was potted as shown below.



Write an equation for the line with numerical values for R_O and α.

2. The equation between two variables W and f are given below:

$W = R^2 + ab\, f^2$

R, a and b are constants.
(a) What values would you take along the X and Y axes to obtain a straight line?
(b) What does the slope of the graph in (a) represent?
(c) What is the intercept of the graph in (a)?

3. The relationship between two variable quantities *v* and *z* is given by the equation

$v = 5.0 + bz^2$

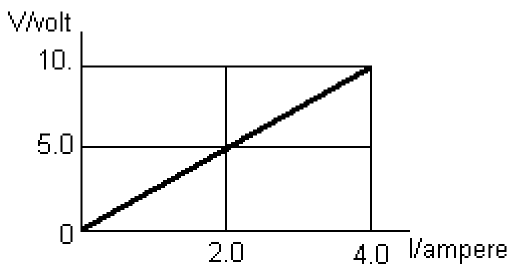
b is a constant.
(a) Which quantities would you take along the X and Y axes to obtain a straight line?
(b) What does the slope of the graph in (a) represent?
(c) What is the intercept of the graph in (a)?

4. Six measured samples of benzene were weighed separately yielding the following

Volume/cm^{-3}	10.	20.	30.	40.	50.	60.
Mass/g	9.0	18.2	26.8	35.5	45.4	53.7

(a) Plot a graph of the mass m in gram against the volume V in cm^3. When stated this way, the first stated quantity (m) should be on the y-axis and the second quantity, V, should be on the x-axis.
(b) What type of proportion exists between m and V? What evidence have you for your conclusion?
(c) Express m as a function of V.

5. The figure below shows how the voltage V across a particular piece of nichrome wire varies with the electric current I through the wire.



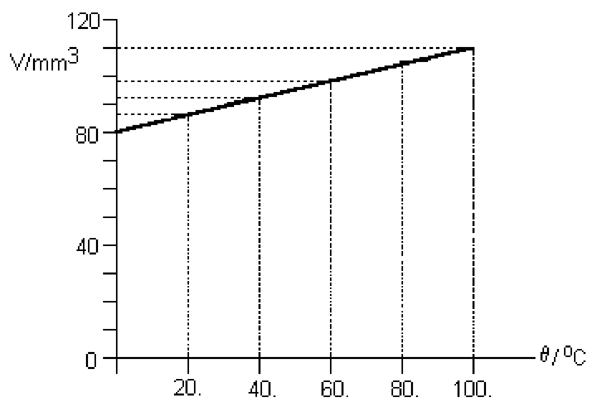
(a) Is V directly proportional to I ?
(b) Express V in terms of I.

6. The relationship between two variable quantities T and r is given by the equation:

$$T = 2\pi\sqrt{\frac{\frac{1}{12}ML^2 + 2mr^2}{\kappa}}$$

In the equation all other quantities are constants. r is the independent variable.
(a) Which quantities would you take along the X and Y axes to obtain a straight line?
(b) What would the slope be?
(c) What is the Y-intercept?

7. In an experiment investigating how the Celsius temperature θ affected the volume V of an enclosed sample of air at a constant pressure, a student's graphed results appeared as shown in the figure below.



(a) Can she say that V is directly proportional to θ ?
(b) Is ΔV directly proportional to Δθ ?
(c) From the graph express V in terms of θ.

8. The temperatures of cities are given below.

World Weather

CITY	°C	°F
Canberra	22°C	72°F
London	12°C	54°F
Moscow	-8°C	18°F
New Delhi	36°C	97°F
Rio de Janeiro	26°C	79°F
Singapore	32°C	90°F
Toronto	4°C	39°F

(a) Plot a graph of °F versus °C.
(b) Using the graph, obtain a general relationship between the Fahrenheit and Celsius scales.

9. The data below represents the force versus extension for a spring.

F/N ($\pm$ 0.1 N)	x/m ($\pm$0.01 m)
0	0
1.0	0.05
2.0	0.09
3.0	0.15
4.0	0.19
5.0	0.24
6.0	0.29
7.0	0.33
8.0	0.39

(a) Plot a graph of F versus x. **Use graph paper.**
(b) Determine the force constant (the slope). Include units and uncertainty values.

10. A circle of radius r is drawn and the area is determined. The following data shows the result.

r/cm ($\pm$0.1)	Area ($\pm$0.2 cm^2)
0	0
1.1	3
1.5	7.2
2.0	12.6
2.5	19.6
3.0	28.4
3.5	38.5
4.0	50.1

(a) What quantities have to be taken along the y- and x- axes to obtain a straight-line graph?
(b) Plot a graph of straight-line graph. **Use graph paper.**
(c) Determine the value of pi with its uncertainty values.

11. A circuit is set up to investigate the relationship between the current I through a resistor and the resistance, R. The equation for the experiment is V=IR, where V is a constant. Resistance is the independent variable. The results are given below.

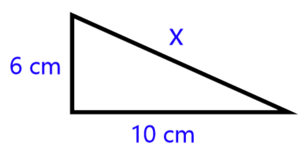
R/Ω ($\pm$0.5Ω)	I/A ($\pm$ 0.1 A)
18.0	0.6
16.0	0.6
14.0	0.7
12.0	0.8
10.0	1.0
8.0	1.3
6.0	1.7
4.0	2.5
2.0	5.0

(a) Which quantities would be taken along the x- and y- axes to obtain a linear equation?
(b) What quantity is represented by the slope?
(c) Determine the slope. Include units and uncertainty values.

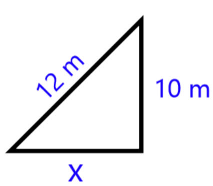
RIGHT-ANGLED TRIANGLES

12. Use the Pythagorean theorem to find the missing side (x) for each of the following right-angled triangle. **Show your work.**

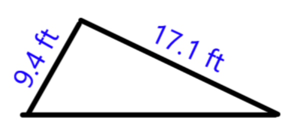
(a)



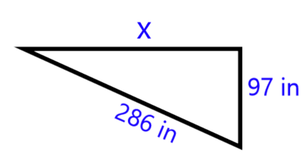
(b)



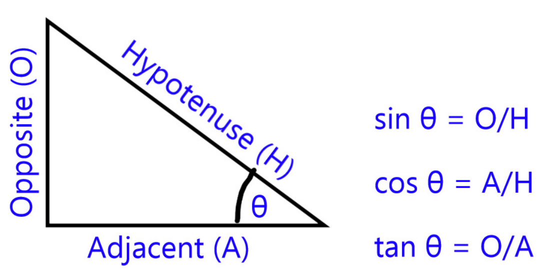
(c)



(d)

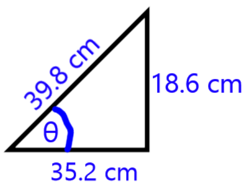


SOH CAH TOA



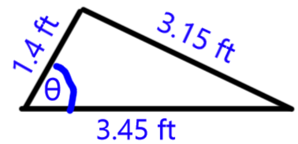
13. Find sin θ for each of these triangles. Make sure your calculator is in degree mode.

(a)



sin θ = __________

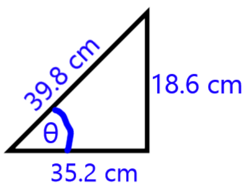
(b)



sin θ = __________

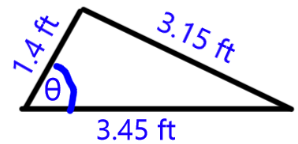
14. Find cos θ for each of these triangles. Make sure your calculator is in degree mode.

(a)



cos θ = __________

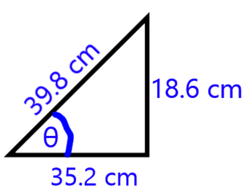
(b)



cos θ = __________

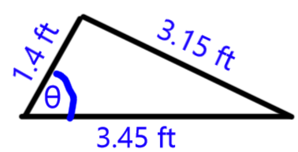
15. Find tan θ for each of these triangles. Make sure your calculator is in degree mode.

(a)



tan θ = __________

(b)



tan θ = __________

16. Find the angle for the values given. Your calculator must be in degree mode.

(a) tan θ = 0.336

θ = ________

(b) sin θ = 0.62

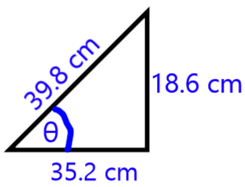
θ = ________

(c) cos θ = 0.44

θ = ________

17. Find the angle, θ, for each of these triangles. Make sure your calculator is in degree mode. **Show your work.**

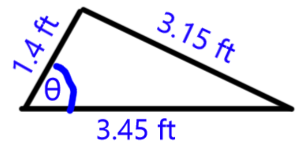
(a)



Work:

θ = _______

(b)

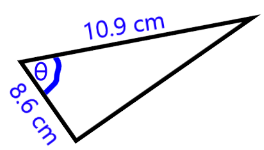


Work:

θ = _______

18. Find the angle, θ, for each of these triangles. Make sure your calculator is in degree mode. **Show your work.**

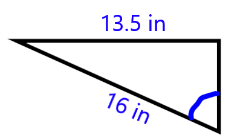
(a)



Work:

θ = _______

(b)

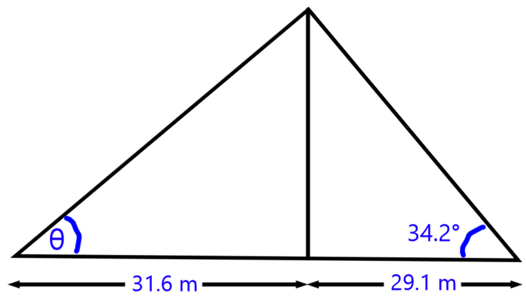


Work:

θ = _______

19. Find the missing angle, θ. Make sure your calculator is in degree mode. **Show your work.**

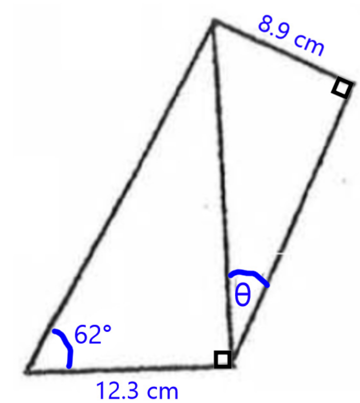
(a)



Work:

θ = _______

(b)



Work:

θ = _______

20. Solve for k from this equation. **Show each step.**

$$T = 2\pi\sqrt{\frac{m}{k}}$$

k =

21. Solve for t. Show your work.

$$v = v_o + at$$

t =