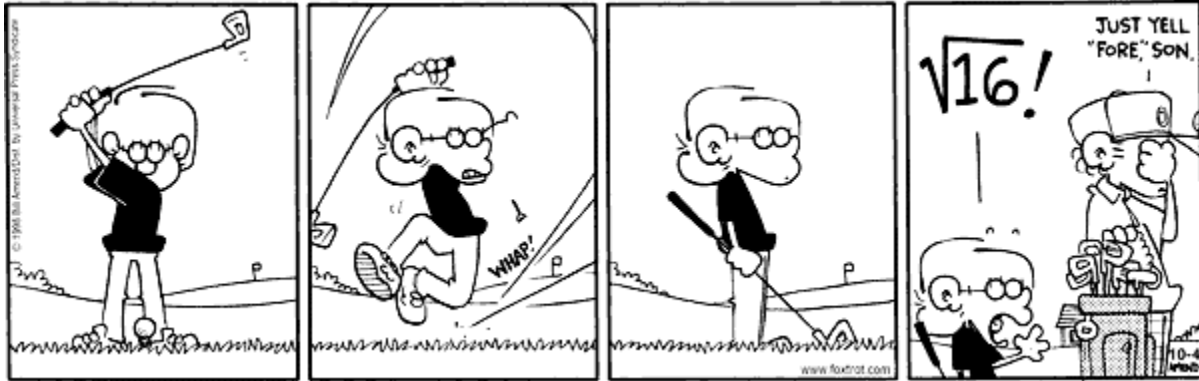


Physics Skills (a.k.a. math review)



PART I. 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 II. SCIENTIFIC NOTATION

The following are ordinary physics problems. Write the answer in scientific notation and simplify the units.

$$1. T_s = 2\pi \sqrt{\frac{4.5 \times 10^{-2} \text{ kg}}{2.0 \times 10^3 \text{ kg/s}^2}} =$$

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

$$3. F = 9 \times 10^{-9} \frac{\text{N} \cdot \text{m}^2}{\text{C}^2} \left(\frac{(3.2 \times 10^{-9} \text{ C})(9.6 \times 10^{-9} \text{ C})}{(0.32 \text{ m})^2} \right) =$$

$$4. \frac{1}{R_p} = \frac{1}{4.5 \times 10^2 \, \Omega} + \frac{1}{9.4 \times 10^2 \, \Omega} \quad R_p =$$

$$5. e = \frac{(1.7 \times 10^3 \text{ J}) - (3.3 \times 10^2 \text{ J})}{(1.7 \times 10^3 \text{ J})} =$$

$$6. (1.33) \sin 25.0^\circ = (1.50) \sin \theta \quad \theta =$$

$$7. K_{\max} = (6.63 \times 10^{-34} \text{ J} \cdot \text{s})(7.09 \times 10^{14} \text{ s}^{-1}) - (2.17 \times 10^{-19} \text{ J}) =$$

$$8. \gamma = \frac{1}{\sqrt{1 - \frac{2.25 \times 10^8 \text{ m/s}}{3.00 \times 10^8 \text{ m/s}}}} =$$

PART III. FACTOR-LABEL METHOD FOR CONVERTING UNITS

A very useful method of converting one unit to an equivalent unit is called the **factor-label 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**,

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

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

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

Carry out the following conversions using the factor-label method. 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, 3×10^8 m/s, to km/day.

6. Convert 823 nm to m

7. 8.8×10^{-8} m to mm

8. 1.5×10^{11} m to μm

9. 7.6 m^2 to cm^2

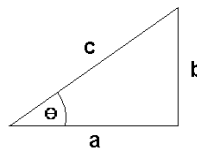
10. 8.5 cm^3 to m^3

PART IV. TRIGONOMETRY AND BASIC GEOMETRY

Solve for all sides and all angles for the following triangles. Show all your work.

Example:

SOH CAH TOA



$$\sin \theta = \frac{\text{opp}}{\text{hyp}}$$

$$\cos \theta = \frac{\text{adj}}{\text{hyp}}$$

$$\tan \theta = \frac{\text{opp}}{\text{adj}}$$

Your calculator must be in **degree** mode! **Show all your work.**

1. $\theta = 55^\circ$ and $c = 32$ m, solve for a and b

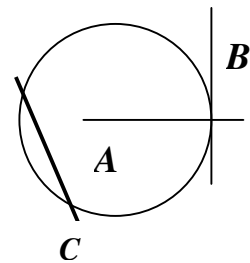
2. $\theta = 45^\circ$ and $a = 15$ m/s, solve for b and c .

3. $b = 17.8$ m and $\theta = 65^\circ$, solve for a and c .

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

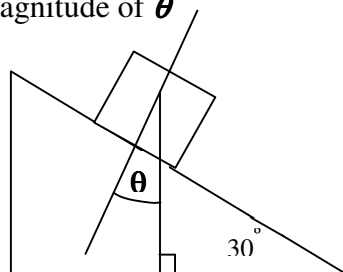
What is line ***B*** in reference to the circle?

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



What is line ***C***?

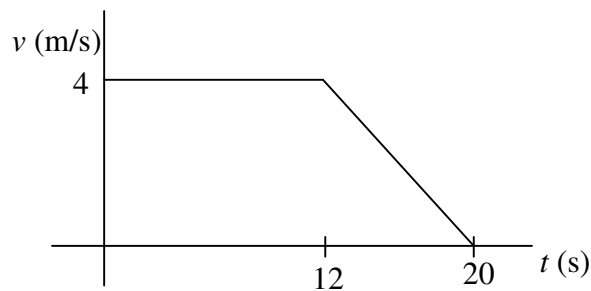
5. Write down the magnitude of θ



6. The radius of a circle is 5.5 cm,
a. What is the circumference in meters?

b. What is its area in square meters?

7. What is the area under the curve below? Show your work and include the appropriate units.



PART V. 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.

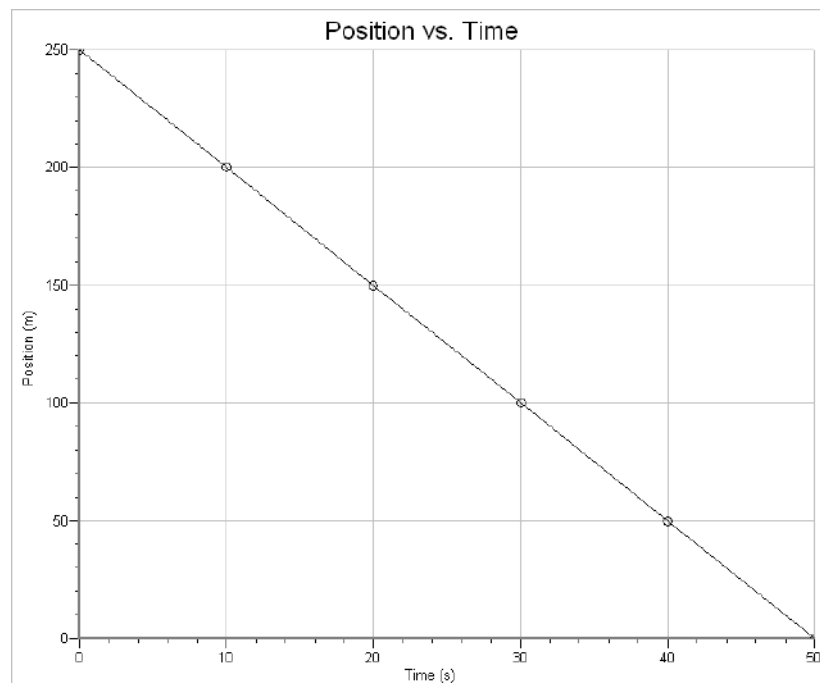
4. Plot the independent variable on the horizontal (x) axis and the dependent variable on the vertical (y) axis. Plot each data point. Darken the data points.

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 clearly 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.

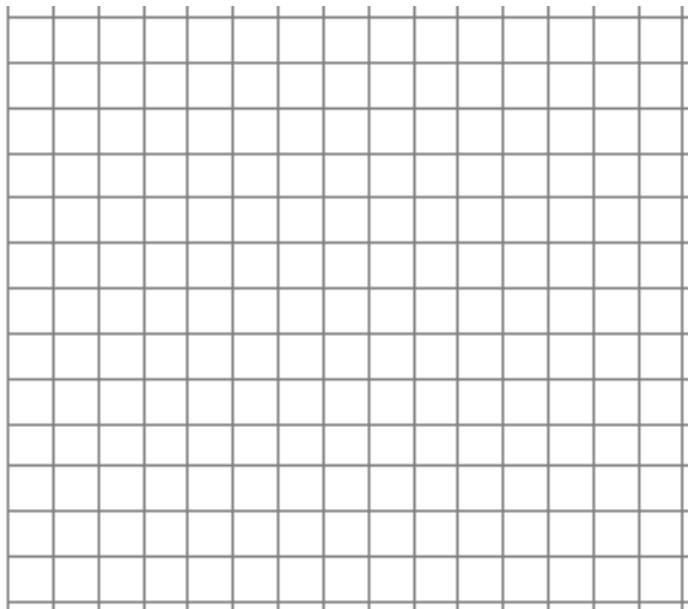
The graph shown on the next page was prepared using good graphing techniques. Go back and check each of the items mentioned above.



Graph the following sets of data using proper graphing techniques.

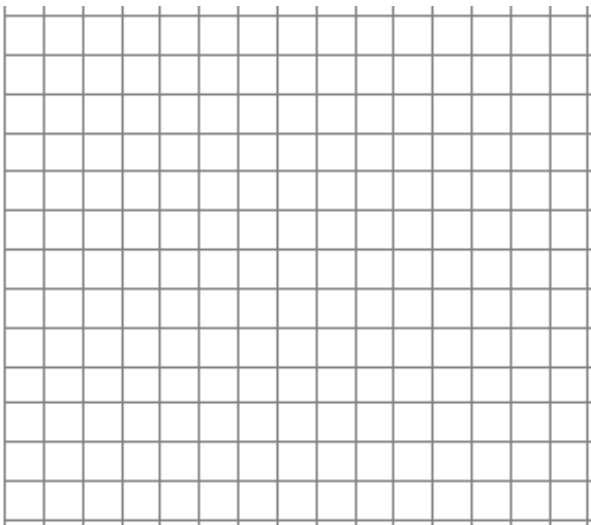
The first column refers to the y -axis and the second column to the x -axis

1.



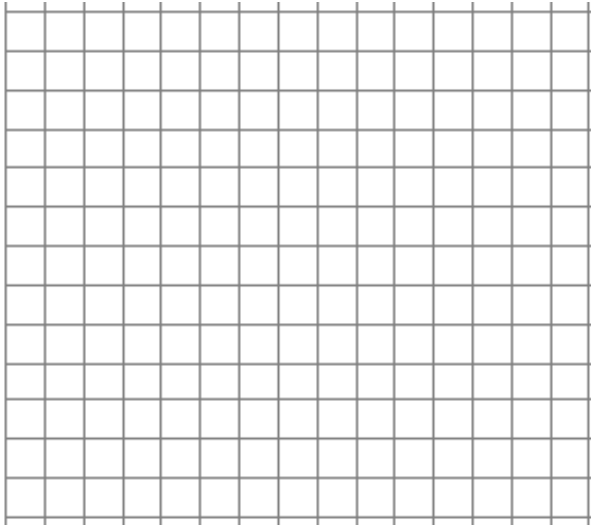
Volume (mL)	Pressure (torr)
800	100
400	200
200	400
133	600
114	700
100	800
80	1000

2.



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

3.

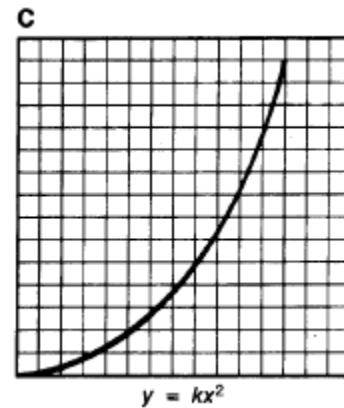
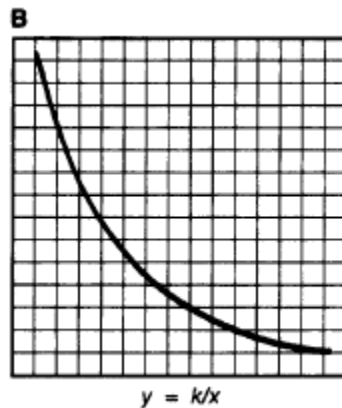
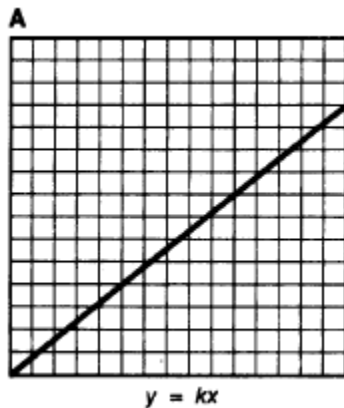


Speed (m/s)	Time (s)
0	0
20	1
45	2
60	3
84	4
105	5

PART V. 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.

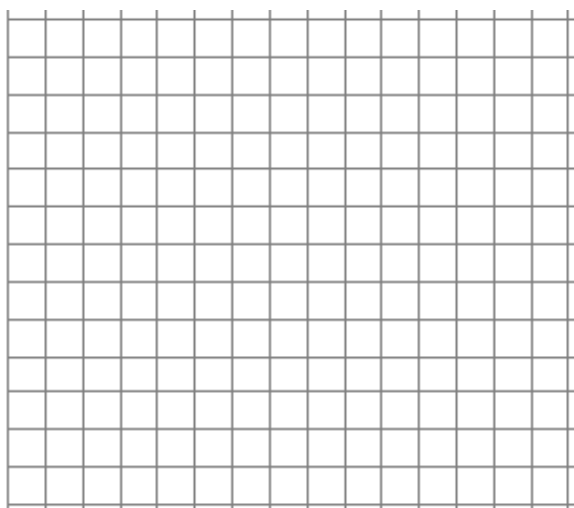
1. Suppose you recorded the following data during a study of the relationship of force and acceleration. Prepare a graph showing these data.



Force (N)	Acceleration (m/s ²)
10	6.0
20	12.5
30	19.0
40	25.0

- 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/s²)
- 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/s²?
- f. What is the acceleration when the force is 50.0 N?

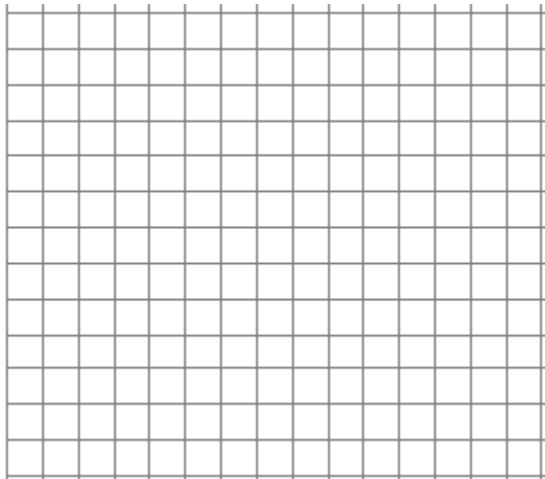
2. The following data show the distance an object travels in certain time periods. Prepare a graph showing these data.



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	

e. What is the slope of the graph? Remember to include units with your slope.

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 meterstick 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 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. ____