AP Physics 1 Summer Assignment

Welcome to AP Physics 1! First, check that you find AP Physics 1 2019-2020 on your eCampus (after May 15, 2019). Accept the invitation! The class syllabus and other important information will be found there. If you are NOT able to find the course on your eCampus page, send an email to Amber_Morgan@scps.k12.fl.us with your name, course (AP Physics 1), and student ID number before June 26, 2019. (After that, you might have to wait a few days for a response.)

Next, complete this review. This summer work WON'T be collected, but I expect each person to have this printed out and completed on the very first day. We'll be going over it and you should be able to discuss your answers. If you can do all this stuff, you'll be fine. If you've got a couple of questions that gave you pause but it was mostly straightforward for you, that's ok, too. If you're struggling with this, however, you should think about taking Physics I Honors instead.

First, some basic algebra skills review:

I. The following are example math problems. Place the answer in **correct scientific notation**, when appropriate, and simplify the units. Work with the units, cancel units when possible, and **show the simplified units in the final answer**. Make sure your calculator is in degree mode when dealing with angle measurements.

a. $T_p = 2\pi\sqrt{\dfrac{125.4\text{ cm}}{9.81\text{m/s}^2}} =$ _______________

b. $K = \dfrac{1}{2}\left(3.6\times10^2\text{ kg}\right)\left(2.32\times10^5\text{ m/s}\right)^2 =$ _______________

c. $F = \left(8.99\times10^9\,\dfrac{N\times m^2}{C^2}\right)\dfrac{\left(4.2\times10^{-9}C\right)\left(8.6\times10^{-9}C\right)}{\left(0.22m\right)^2} =$ _______________

d. $\dfrac{1}{R_p} = \dfrac{1}{4.5\times10^2\,\Omega} + \dfrac{1}{9.4\times10^2\,\Omega}$ $R_P =$ _______________

e. $(1.33)\sin 35.0^o = (1.50)\sin\theta$ $\theta =$ _______________

For each of the following equations, solve for the variable in **bold** print in terms of the other variables.

f. $\lambda = \dfrac{\mathbf{h}}{p}$ _______________

g. $F\left(\Delta\mathbf{t}\right) = m\Delta v$ _______________

h. $U = \dfrac{G\mathbf{m}_1 m_2}{r}$ _______________

i. $v^2 = v_0{}^2 + 2\mathbf{a}\Delta x$ _______________

j. $n_1\sin\theta_1 = n_2\sin\boldsymbol{\theta}_2$ _______________

k. $\dfrac{1}{s_i} + \dfrac{1}{s_o} = \dfrac{1}{\mathbf{f}}$ _______________

II. Now some conversion questions.

A very useful method of converting one unit to an equivalent unit is called the **factor-label method** of unit conversion. ***Example:*** 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.

Conversions: 1000 **m** = 1 **km** and 3600 **s** = 1 ***h***,

(25 km/h)(1000 m/1 km)(1 h / 3600 s) = 6.9 m/s

Carry out the following conversions.

1. How many seconds are in a year? How many years in a second?

2. Convert 526 km to cm.

3. Convert 0.0450 kg to mg.

4. Convert 82.5 cm/min to m/s.

5. Convert the speed of light in vacuum, 3.00×10^{8} m/s, to km/day.

6. Convert 823,079,000 nm to m

7. Convert 8.81×10^{-8} m to nm

8. Convert 1.50×10^{11} m to km

9. Convert 7.60 m^2 to cm^2

10. Convert 80.5 cm^3 to m^3

11. Convert 18.5 g/cm^3 to kg/m^3

12. Convert 87.55 km/h to m/s.

13. Convert 200.00 g/cm^3 to mg/mL.

14. Convert 80.0 km^2 to m^2

III. Drawing and Interpreting Graphs.

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. Choose the scale in such a way that the data will span the entire axis. Figure 3 depicts the result for right scales in both directions.

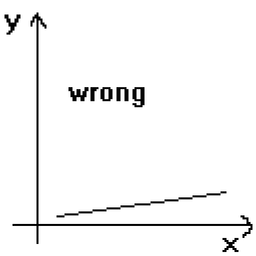


Fig. 1

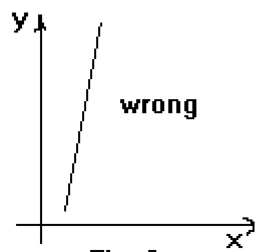


Fig. 2

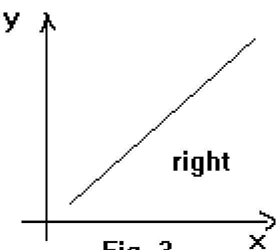


Fig. 3

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. NEVER force a graph through the origin!

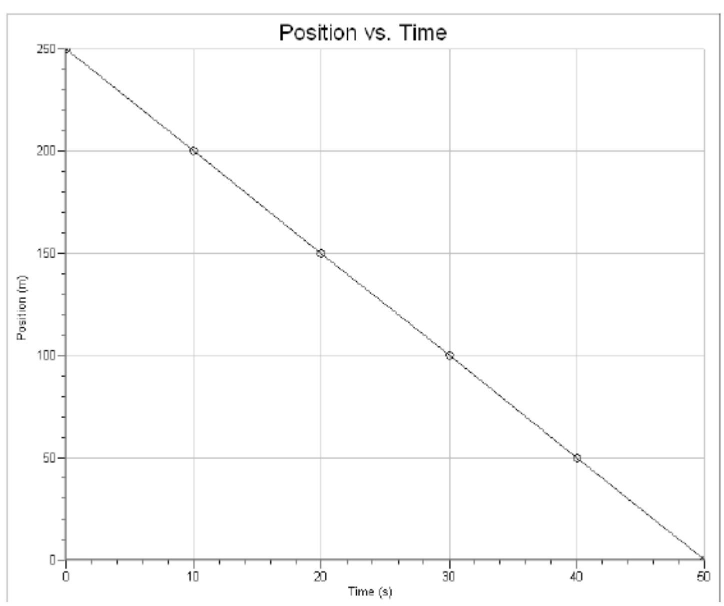
4. Plot the independent variable on the horizontal (x) axis and the dependent variable on the vertical (y) axis (unless specifically instructed otherwise). Plot each data point. Darken the data points.

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. At minimum, VERTICAL axis variable vs. HORIZONTAL axis variable for a title.

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 to the right was prepared using good graphing techniques. Go back and check each of the items mentioned above.



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

1.

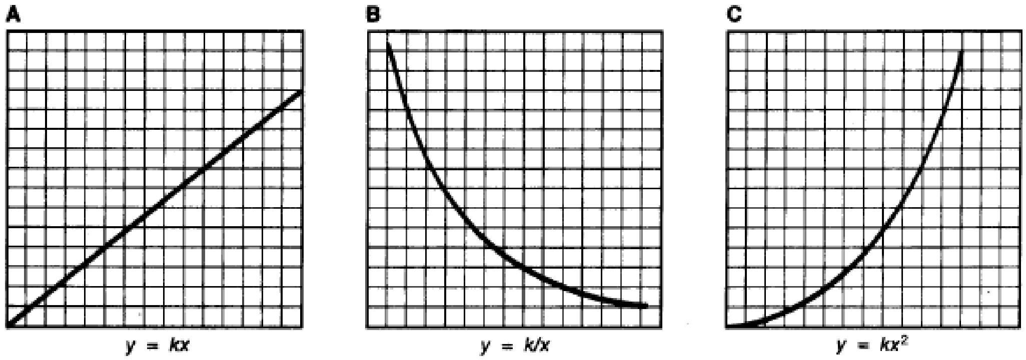
Volume (mL)	**Pressure (torr)**
800	**100**
400	**200**
200	**400**
133	**600**
114	**700**
100	**800**
80	**1000**

2.

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

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.

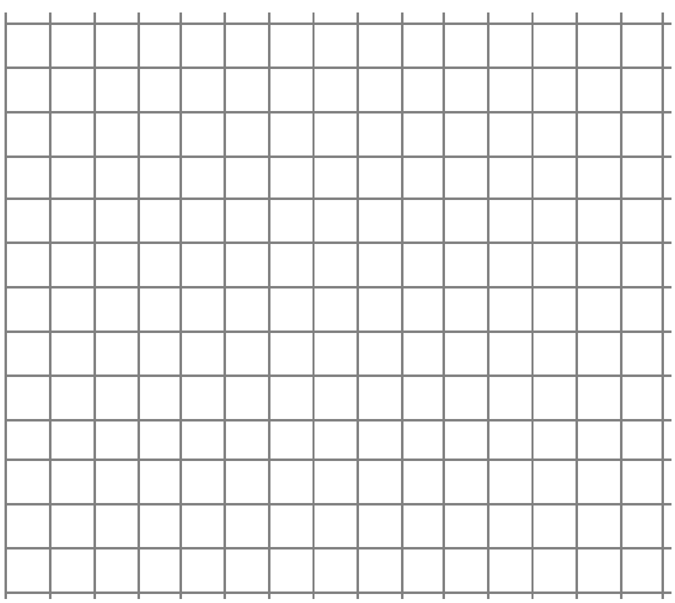
There are **three** relationships that occur frequently in physics:



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)
10.0	**6.0**
20.0	**12.5**
30.0	**19.0**
40.0	**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/s^2)
c. Write an equation for the line.
d. What is the value of the force for an acceleration of 15 m/s^2?
e. What would be the acceleration when the force is 50.0 N?

2. The following data show the position of an object at certain times. Prepare a graph showing these data.

Position (m)	Time (s)
0	**0**
2.0	**1.00**
8.0	**2.00**
18.0	**3.00**
32.0	**4.00**
50.0	**5.00**

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**
2.0	
8.0	
18.0	
32.0	
50.0	

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

3. Plot a graph showing the relationship between frequency and wavelength of electromagnetic waves:

Frequency (kHz)	**Wavelength** (m)
150	2000
200	1500
300	1000
500	600
600	500
900	333

a. What kind of curve did you obtain?

b. What is the relationship between the variables?

c. Use the graph to determine the wavelength of an electromagnetic wave of frequency 350 kHz

d. Use the graph to determine the frequency of an electromagnetic wave of wavelength 375 m.

e. What should you graph to linearize the data? What would the slope of the line tell you?

IV. Understanding and Interpreting 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.

1. Classify the following examples as systematic or random error.

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

b. A clock used to time an experiment runs slow. ______________

c. Two observers are timing a runner on a track. Observer A is momentarily distracted and starts the stopwatch 0.5 s after observer B. _______________

d. Friction may cause the pointer on a balance to stick. _____________

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

2. Mary tested how fast blocks of clay dry under a bright light. She recorded the time it took different-sized blocks to dry.

Volume of block (cm^3)	*27*	*8*	*43*	*125*	*16*	*166*	*64*	*91*
Time to dry (min)	*5*	*3*	*7*	*21*	*4*	*37*	*9*	*14*

a) Graph her data appropriately (on the next page).

b) Describe the shape of the graph that emerges from Mary's data.

c) Mary hypothesized that the drying time for a clay block was **directly proportional** to the block's volume. In other words, her hypothesis predicted that her data would form a straight line. Was her hypothesis correct? Justify your answer.

d) Mary had one additional data point with values of 142 cm^3 and 39 minutes. Because this point was different from her other data points, she decided she had made an error while performing that trial. Plot that point on your graph and explain her thinking.

V. Reading Measuring Instruments

All measurements are limited by some uncertainty due to the measuring process or the measuring instrument. There will always be a +/- range used to be sure the true value is included. By using measuring instruments capable of finer measurements we can reduce the uncertainty in our measurements, but we can never entirely eliminate it.
Examples: Using a balance that weighs to the thousandths place will give you a finer measurement and less uncertainty than a balance that weighs to the hundredth place, because you are certain of more digits in your measurement using the balance that weighs to the thousandths place.
Using a millimeter ruler to measure length will give a finer measurement with less uncertainty than when you use a centimeter ruler.
Using a graduated cylinder marked off in units of tenths will give you a finer measurement with less uncertainty than a graduated cylinder marked off in units of ones.
When you are recording your measurements, they are made up of digits that you are certain of and one uncertain digit at the far right. It is still a SIGNIFICANT digit, however!
Example: You record a measurement of 121.98. You are certain of 121.9, the 8 is your uncertain digit.

Reading the graduated cylinder

When a liquid is placed into a glass container it forms a **meniscus**, a curved surface that is lower in the middle than at the edges. In order to read the graduated cylinder correctly, it must be placed on a stable surface such as the desktop of the work area. Never try to read the graduated cylinder while holding it in your hand. Your eye must be level with the bottom of the meniscus. Do not look down at or up at the bottom of the meniscus.

To determine the volume of liquid use the number that is directly at or below the bottom of the meniscus. **Read to the unit the graduated cylinder is marked off in (your certain digits), THEN ESTIMATE ONE MORE PLACE.** If the graduated cylinder is marked off in units of one, your volume reading must go to the tenths place in order to have your reading done correctly.
If the graduated cylinder is marked off in units of tenths, then your volume reading must go to the hundredth place.

Remember: Read to the unit you are certain of, then estimate one more place.

Examples: Using a 100 mL graduated cylinder (marked off in units of ones, the bottom of the meniscus is between 12 and 13, but closer to 12 than 13. You read it as 12.3 mL, with the 3 being your best estimation of where the bottom of the meniscus is. You are certain of the 12, the 3 is your uncertain (but still significant!) digit.

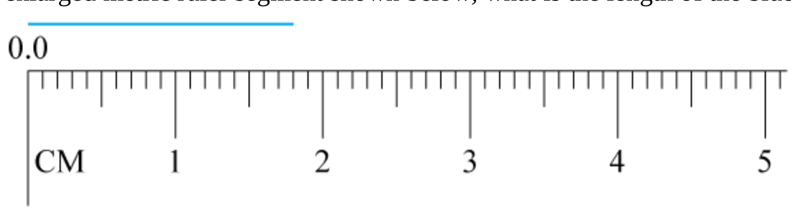
Reading the centimeter ruler

The centimeter ruler is marked off in units of tenths so you must take measurements to the nearest tenth of a centimeter and then estimate the hundredth place. All centimeter ruler measurements will have two places to the right of the decimal point.

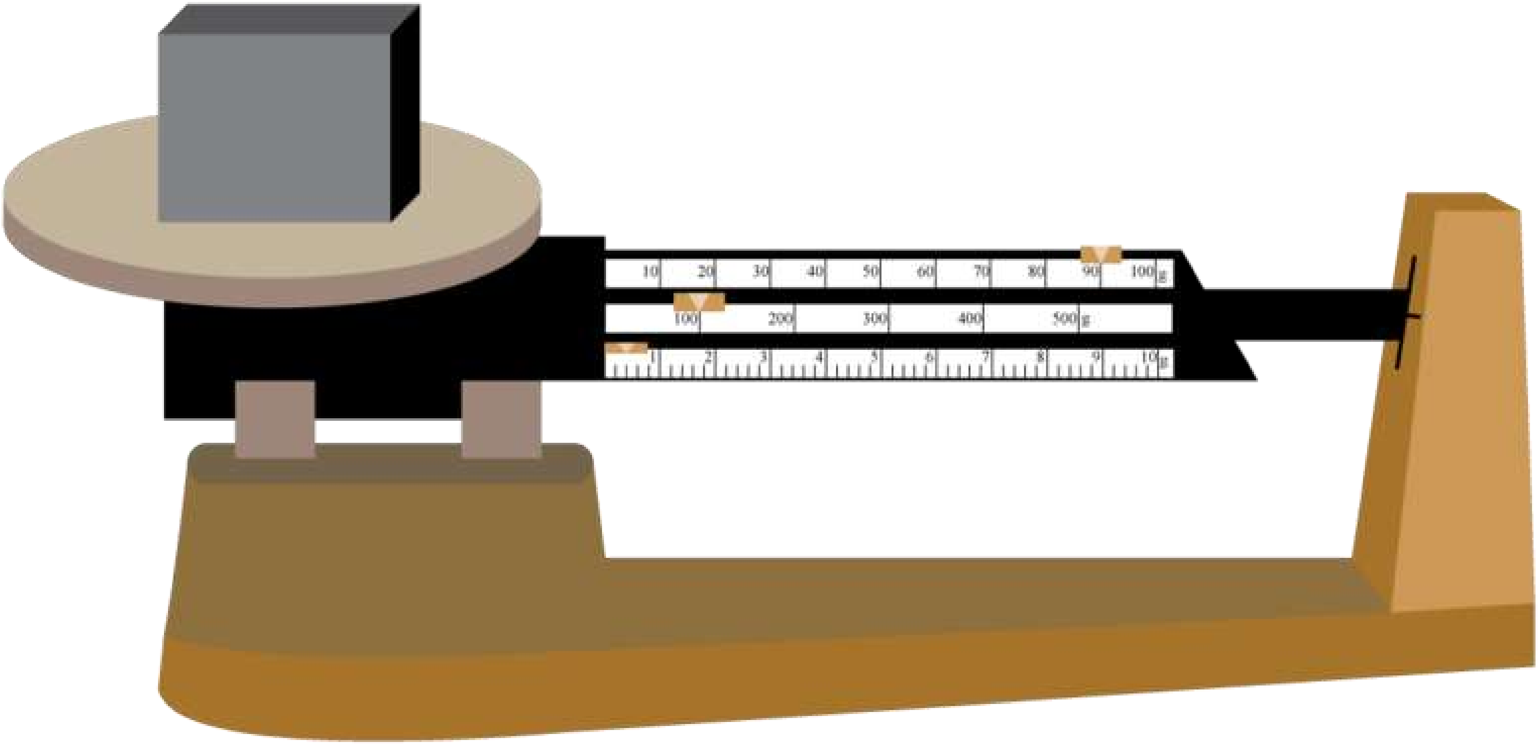
Remember: Read to the unit you are certain of, then estimate one more place.

Example: If you measure a line and find it measures exactly 12 cm, then your measurement is 12.00 cm.
Example: If you measure a line and find it measures between 1.5 and 1.6 cm but it is closer to 1.6, you estimate the uncertain digit. Your measurement could be 1.68 cm. The 8 is the uncertain digit and is estimated.

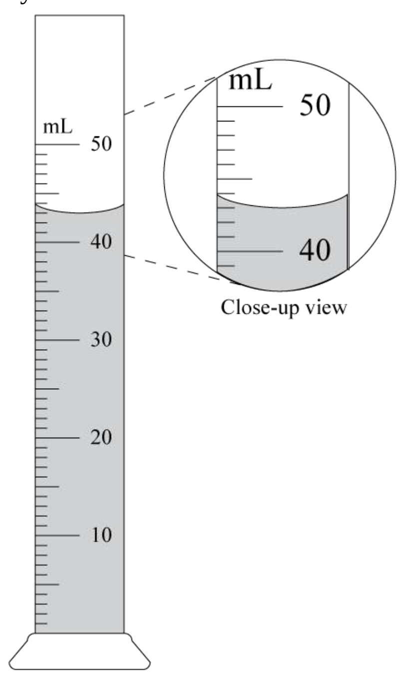
1. Using the enlarged metric ruler segment shown below, what is the length of the blue line in centimeters?

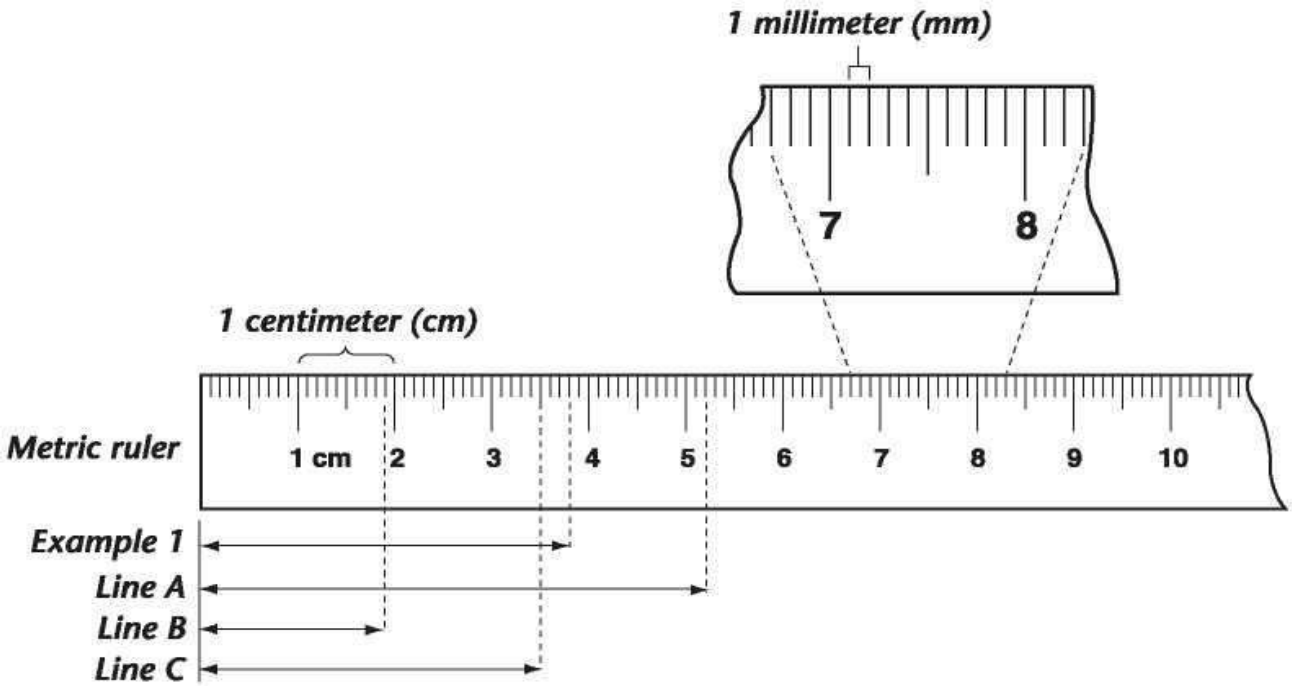


2. Assume that an object has been placed in the pan of a triple beam balance. The scales of the balance are shown below. What is the mass of the object?



3. How much liquid does this graduated cylinder contain?





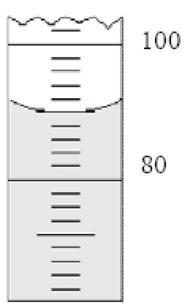
4 a. How many millimeters long is Line A? ________________________________

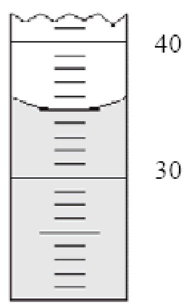
b. How many centimeters long is Line A? ________________________________

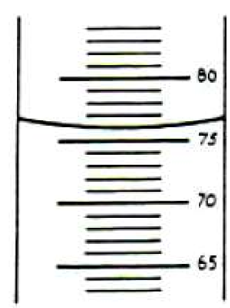
c. How many millimeters long is Line B? ________________________________

d. How many centimeters long is Line B? ________________________________

5. Determine the volume filled (in mL) for each of the graduated cylinders shown below.





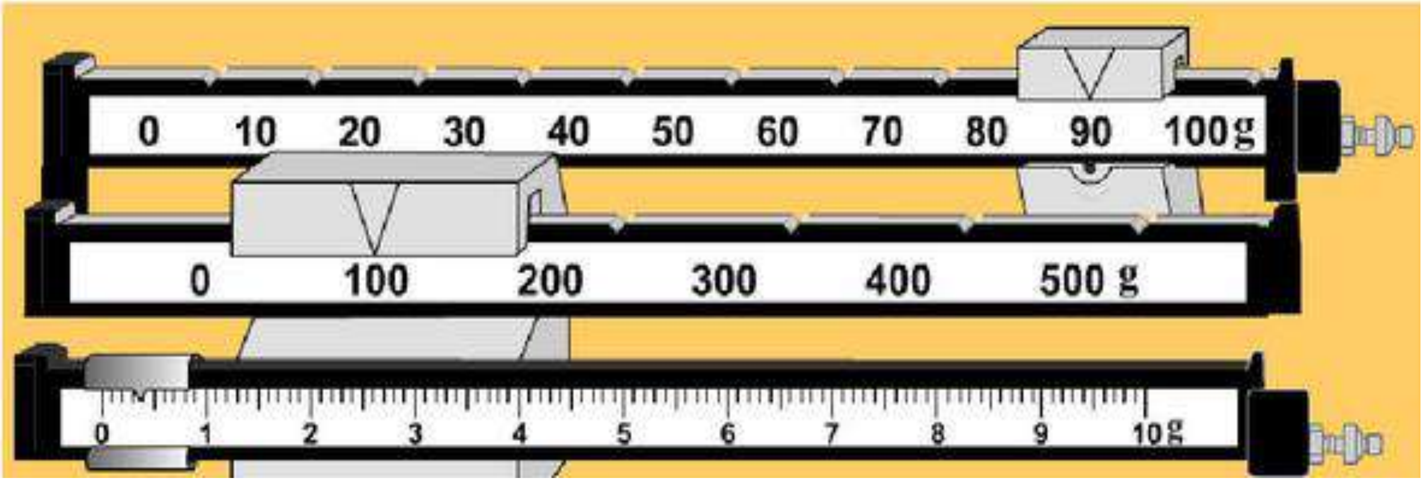


A. ____________________
B.

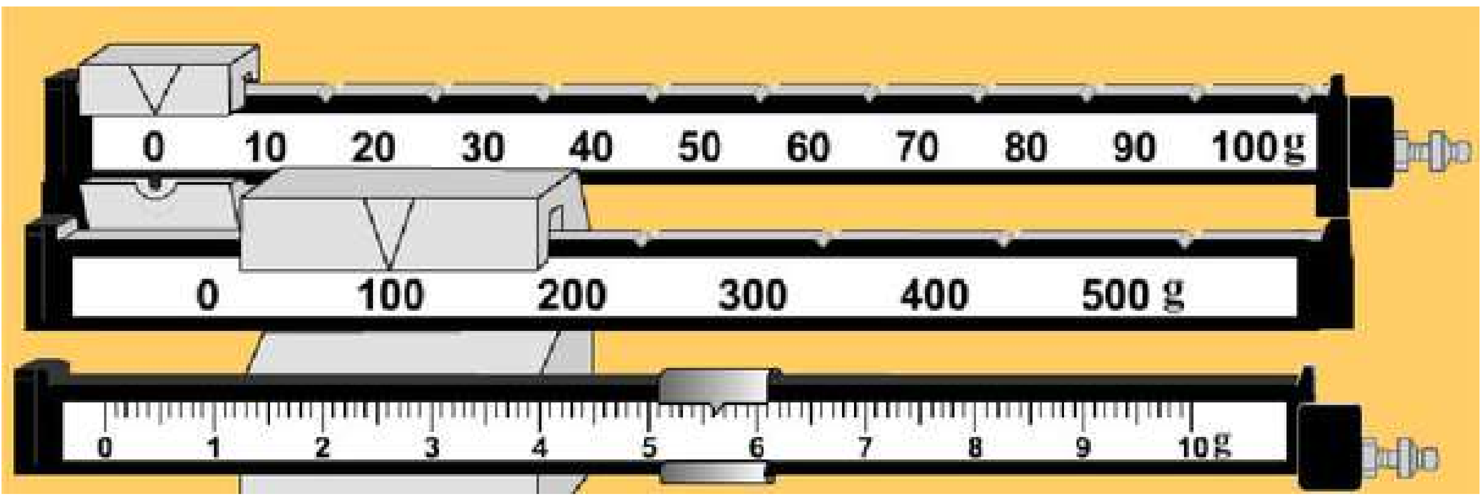
B. ____________________

C. ___________________

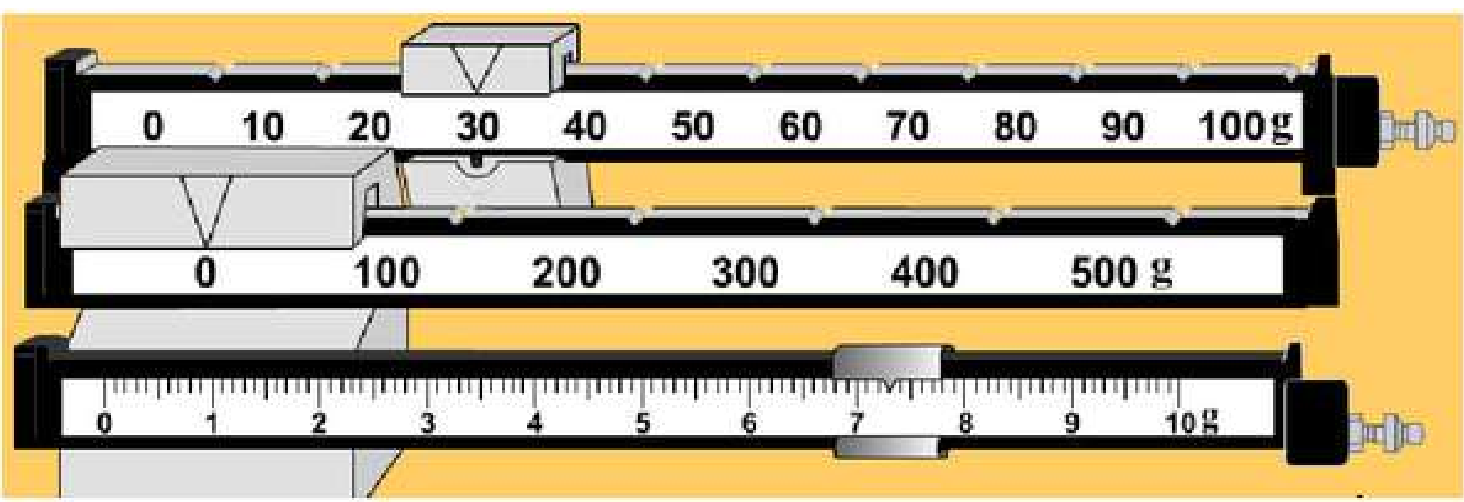
6. Determine the mass reading for each triple beam balance shown.



A. ________________________________



B. ________________________________



C. ________________________________

VI. Calculations with Measurements

Most often, the measurements we take in the lab do not give us the answer that we are looking for until we use them in some sort of calculation. . In all cases, the precision of a calculation is limited by the last precise datum used in the calculation. We want to use this information to show the informed reader how confident we are in the results of a calculation using our data.

Addition/Subtraction Rule

When the calculation involves simple addition or subtraction, the rule is simple. The result of the calculation is rounded off to the same decimal place as the datum having the least number of decimal places (after being sure all data are in the same units!).

Examples:

5.074 cm (to thousandths)	17.453 mL (to thousandths)
+ .10 cm (to hundredths)	-1.2 mL (to tenths)
5.203 cm = 5.20 cm (round to hundredths)	16.253 m L = 16.3 mL (round to tenths)

When the calculation involves multiplication or division the precision of the result is given by counting significant figures (SF). The **rules for counting the number of significant figures** in a number are:

Rule #1

All non-zero digits and all zeroes surrounded by non-zero digits are significant. Beginning zeroes are never significant.

Examples:	112.2 has 4 SF	1002.6 has 5 SF	0.0028 has 2 SF
	25 has 2 SF	1.0026 has 5 SF	1.0028 has 5 SF

Note that rule #1 covers all numbers except those which end with a zero. When we calculate with a datum of 9.80, for example, we mean that our measurement was accurate to the hundredths place and, therefore, our confidence in our calculation is influenced by the ending zero, i.e. the zero is significant.

Another example of a measurement ending with zero is (1500). If the smallest division on the measuring device used for this measurement was 1000 (therefore the 5 was estimated), then, only the 1 and 5 are significant. **However, if the smallest division was 10, then the last zero was estimated and *all four* digits are significant** (i.e. they increase our confidence in the accuracy of our calculation). There are two common way to record measurements so that a reader knows how precisely we measured numbers such as this. The first is to write the number in scientific notation keeping only the significant zeroes. Therefore, writing 1.500×10^3 indicates 4 SF whereas writing 1.5×10^3 is the same as writing 1500 and indicates only 2 SF. The second method is to follow the number with an explicit decimal point (note: only useful when all of the ending zeroes are significant). Thus, 1500. indicates 4 SF while 1500 indicates only two. The rules for ending zeros can be summarized as follows

Rule #2

Ending zeroes are significant only when they are the last digit to the right of the decimal point or are followed by an explicit point.

Examples:
$1200 = 1.2 \times 10^3$ has 2 SF
$1200.0 = 1.2000 \times 10^3$ has 5 SF
$0.0003400 = 3.400 \times 10^{-4}$ has 4 SF
$1{,}200{,}000. = 1.200000 \times 10^6$ has 7 SF
27.0 has 3 SF
0.2800 has 4 SF
400. has 3 SF
30 has 1 SF

Note that all significant zeros have to be written in scientific notation even though it sometimes looks awkward, such as in the example 1,200,000.)

Multiplication/Division Rule

When we perform multiplication or division with data, the answer is rounded off to the same number of significant figures as the datum having the *least* number of significant figures.

Examples: 13.2 x 2.0 = 26 (26.4 rounded to 2 SF)
(note 13.2 has 3 SF; 2.0 has 2 SF)

500./0.03654 = 1.37 x 10^4 (13683.6 rounded to 3 SF)
(note: 500. has 3 SF; 0.03654 has 4 SF)

61.32 x 1.8 = 110 (110.376 rounded to 2 SF)
(note: 61.32 has 4 SF; 1.8 has 2 SF)

1.2365 x 30 = 40 (37.095 rounded to 1 SF)
(note: 1.2365 has 5 SF; 30 has 1 SF, only the '3' is significant)

Practice

1) In the second column, write the number of significant figures in each number. In the third column, write each number in standard scientific notation (i.e. coefficient has only one digit to the left of the decimal place). Note: all significant figures are written in the coefficient.

Number	*# of Significant Figures*	*Scientific Notation* *Remember: all SF's are shown in the coefficient*
a) 1,707		
b) 320.		
c) 4200		
d) 72.07		
e) 0.00060		
f) 0.00723		
g) 98.60		
h) 3.20		
i) 500.0		
j) 10,000.		

2) Add/subtract the following – round to the "least decimal place"

a) 306 m - 12 m

b) 4.20 g + 0.004 g

c) 1306.50 cm – 15.3 cm

d) 175.25 s + 300 s

e) 175.25 s + 30. s

3. Multiply/divide the following – round to "least number of SF." Rewrite all answers in scientific notation.

Be sure to include units in your final answer.

	Answers (to the correct # of SFs)	Scientific Notation (remember: all SFs are shown in the coefficient
a) 601 m x 40. m =		
b) 3000.0 m x 1.7235 m =		
c) 720 kg / 1375 m=		
d) 111.0 m/ 32.3 s =		
e) 0.007270 kg / 0.010 m^3 =		
f) 0.0000032 mol / 0.17 g =		

4. When do I round? *Follow the order of operations you learned in elementary school. Every time you have to change the rounding rule you follow (addition/subtraction to multiplication/division or vice versa), you should round at that time!*

EXAMPLES:

$$x = \frac{4.0\ g}{2.00\ cm^3} + \frac{9.00\ g}{18.00\ cm^3}$$

$$x = 2.0\ g/cm^3 + 0.500\ g/cm^3 = 2.5\ g/cm^3$$

$$x = \frac{4.0\ g + 9.00\ g}{2.00\ cm^3 + 18.00\ cm^3}$$

$$x = \frac{13.0\ g}{20.00\ cm^3} = 0.650\ g/cm^3$$

Your turn:

A) $$x = \frac{10.0\ m}{2.40\ s} + \frac{54.00\ m}{78\ s}$$

B) $$x = \frac{\left(4.5\ {}^{g}/_{cm^3}\right)(11.0\ cm^3) + \left(0.4\ {}^{g}/_{cm^3}\right)(45.0\ cm^3)}{0.360\ g}$$