Physics 4A
Measurement Worksheet

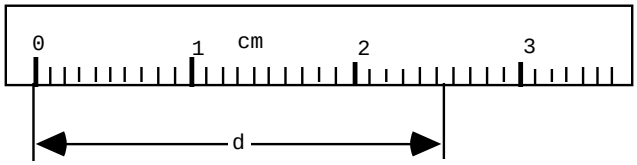
Introduction: This preliminary exercise (**Individualized, No Lab Partners)** is designed to provide a "hands-on" review of measurement, which will include: some familiar or unfamiliar instruments, some SI units, the measuring process, significant figures, derived quantites, and graphing. Before beginning this important exercise, please read the "Significant Figures", "Graphical Analysis Handout", "The Lab Manual Handout", and "The Vernier & Micrometer" handouts.

Part 1: Measurement & SI Units

Directions: Measure the following quantities and report them in the indicated units. Be sure to report the correct number of significant figures.

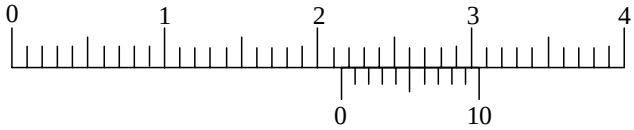
A. What is d in centimeters?

d = _____ cm

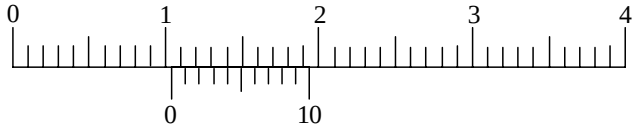


B. During the semester, you will be using verniers calipers to measuring objects in centimeters (cm). Record the caliper reading shown below (*Each small division on the scale below is one* mm.) When you use the vernier calipers in the lab, make sure you read the correct scale since some of the calipers have both inch and centimeter scales.

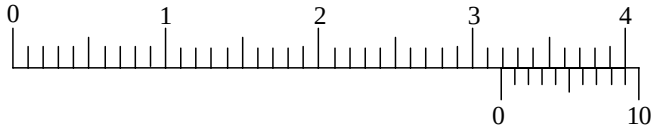
1. _____ cm



2. _____ cm



3. _____ cm



C. Obtain three wires. Use a Micrometer to measure their

Diameter (indicate color of wire):

a. _____ mm b. _____ mm c. _____ mm

D. Obtain a sheet of white copy paper and measure its

a. length : _____ cm b. width: _____ cm

c. thickness: _____ cm d. mass: _____ g

E. Measure Room

Temperature: _____ deg C

F. Measure π by rolling a cylinder out on a piece of paper. Use a Vernier caliper to measure d.

C = _____ d = _____

π = _____ % Error = _____

F. Determine the density of H_2O.

Mass of Graduate: _____ Mass of Graduate + H_2O: _____

Mass of H_2O: _____ Volume of H_2O: _____ Density: _____

Part 2: Significant Figures & Derived Quantities

Directions: Carry out the indicated operations below and report the answer to the correct number of significant figures in the space provided.

1. $145.6 \times 6.2 =$ _____

2. $\frac{53.87}{0.0835} =$ _____

3. $126.34 + 12.785 =$ _____

4. $\sqrt{123.15 m^2} =$ _____

5. $\frac{377.55m - 5.0m}{32.1s} =$ _____

6. $\frac{0.975 + 0.04}{2.061} =$ _____

7. 0.011 has _____ sig. figs

8. 64,340 has _____ sig. figs

9. Write 57,440 to 4 sig. figs using scientific notation: _____

10. Calculate the average of the following measurements (don't forget to apply the rules for sig figs): 2.06cm, 2.18cm, 2.05cm, 2.10cm, 2.11cm, 2.09cm. _____

Express your answers to the following in scientific notation:

11. Add 5.80×10^3 and 6.75×10^2 = _____
12. Multiply 6.687×10^{-3} and 479×10^{-4} = _____
13. Divide 1398×10^{-4} by 8.8469×10^{-3} = _____

Part 3: Graphing

A. Obtain the beaker of pennies, place one on the centigram balance, and measure its mass in grams. Record this mass in a data table made on a separate piece of paper. Now add a penny and measure the mass of both pennies and record in your table. Continue adding pennies, and measuring and recording the total mass for a total of at least fifteen pennies. Now plot a graph of mass vs. number of pennies and evaluate the slope (show your calculation below your data table).

Number of Pennies	Mass of Pennies (g)

Penny	Penny Mass (g)

Does your slope have units? Explain. _____

What does the slope mean? _____

Be sure to attach your <u>data table and graph</u> to this worksheet.

What is the slope of your graph to the correct number of decimal places?_____

B. Weigh each of the pennies individually and list their masses in a table.

Calculate their average mass. _____

How does this compare to the slope of the graph? Why?

_____

Calculate the standard deviation from the mean. $s = \sqrt{\sum \frac{(x_i - \bar{x})^2}{N-1}}$ _____
(**always keep one sig. fig.**)

Calculate the precision the mean $\sigma_m = \frac{s}{\sqrt{N}}$. _____
(**always keep one sig. fig.**)

What is the precision of the balance? _____
(always keep one sig. fig.)

What does the standard deviation of the mean tell you?

_____
_____

How does the precision of the mean compare to the precision of the balance? Should they be the same in this experiment? Why or Why not?

_____
_____
_____

Part 4 Propagation of Errors

Measure the diameter of the given sphere with the Vernier caliper. D=_____cm
What is precision of your Vernier caliper? ΔD=_____cm

Using your knowledge of differential calculus (refer to your calculus textbook), estimate the error in the volume of the sphere. Show your work below. ΔV=_____cm^3

Use a **Vernier caliper** to measure the block's length, L, width, W, and height, H, five times. Make sure you use different locations on the block when you repeat each measurement. Then calculate the average length, width, and height along with their uncertainties. Report values using the format L±ΔL, W±ΔW, and H±ΔH. Finally calculate the average volume of the block along with its uncertainty (using the proper method to propagate the errors).

Trial Number	Length(cm)	Width(cm)	Height (cm)
1			
2			
3			
4			
5			

Average Length = _____cm
Average Width = _____cm
Average Height = _____cm
$(L_{avg})(W_{avg})(H_{avg})$= _____$cm^3$ = _____m^3