

SAN DIEGO MESA COLLEGE

PHYSICS 195 LAB REPORT

Name _____

Date _____ Time _____

Group #: _____

Partners _____

TITLE: Length, Mass, & Density

Objective: In this experiment, you will learn the metric system by performing basic measurement techniques. You will use these techniques to find the density of various objects.

Theory: Physical quantities are always specified relative to a particular standard or **unit**, and the unit should always be stated. For example, if an employer made you an offer to work for 125 per hour, would you accept the offer? Since your boss did not state the **unit** along with the amount, the offer sounds suspect. Surely you would not work for 125 *cents* per hour (not in today's market).

The commonly accepted set of units use today is the *Système International* (SI). The SI system is based on the metric system. The metric system is convenient because it is based on a decimal system (i.e.: powers of ten). Therefore, it simplifies calculations by using a set of prefixes shown below.

Prefix:	Symbol:	Magnitude:	Meaning (multiply by):
Yotta-	Y	10^{24}	1 000 000 000 000 000 000 000 000
Zetta-	Z	10^{21}	1 000 000 000 000 000 000 000
Exa-	E	10^{18}	1 000 000 000 000 000 000
Peta-	P	10^{15}	1 000 000 000 000 000
Tera-	T	10^{12}	1 000 000 000 000
Giga-	G	10^9	1 000 000 000
Mega-	M	10^6	1 000 000
myria-	my	10^4	10 000
kilo-	k	10^3	1000
hecto-	h	10^2	100
deka-	da	10	10
deci-	d	10^{-1}	0.1
centi-	c	10^{-2}	0.01
milli-	m	10^{-3}	0.001
micro-	(mu)	10^{-6}	0.000 001
nano-	n	10^{-9}	0.000 000 001
pico-	p	10^{-12}	0.000 000 000 001
femto-	f	10^{-15}	0.000 000 000 000 001
atto-	a	10^{-18}	0.000 000 000 000 000 001
zepto-	z	10^{-21}	0.000 000 000 000 000 000 001
yocto-	y	10^{-24}	0.000 000 000 000 000 000 000 001

Using the metric system, it is easy to calculate how many millimeters are in 3 kilometers – it's just a matter of moving the decimal place over. However, in the English system it is a lot of work to calculate the number of inches in 3 miles; 12 inches = 1 foot, 5280 feet = 1 mile, These calculations are difficult, if not impossible, to do them quickly in your head.

In today's lab you will use the metric system exclusively to make physical measurements. Just remember that every measured quantity must be assigned a unit!!

Equipment:	Balance (0.01g)	Wooden Blocks
	Meter stick and ruler	Metal Blocks
	Irregular-shaped metal object (~ 200 pennies)	Graduated Cylinder
	Peanut m&m's (provided by instructor)	

Density :

Most would agree that steel is 'heavier' than cotton. This is not really true, because we know that a truck full of cotton clearly weighs more than a steel paperclip. What we should say is that steel is more **dense** than cotton. The density **D** of an object is defined as its mass per unit volume:

$$D = \frac{\text{mass}}{\text{volume}} \quad \text{or} \quad D = \frac{m}{V}, \quad \text{where } m \text{ is the mass of the object and } V \text{ its volume.}$$

Density is a measure of how closely packed the atoms of a substance are. Note that density is a property of a substance, not a property of a specific object. For example, the density of water is 1 g/cm^3 . (A cubic centimeter is about the size of a sugar cube.) So if you took one teaspoon of water out of a swimming pool, and found its density by dividing its mass (in grams) by its volume (in cubic centimeters), you would get 1 g/cm^3 . Now you want to find the density of water in your cousin's pool. But she lives 2000 miles away. So you ask her over the telephone to do the same experiment. She takes 1 gallon of water out of her pool, and finds its density by dividing its mass (in grams) by its volume (in cubic centimeters). She would find that the density of water is 1 g/cm^3 ! The same as your water! So it doesn't depend *just* on the mass or *just* on the volume of a substance, but rather those two quantities together.

Part 1: Density of Wood and Lead

Procedure:

A: Block of Wood

1. Use the balance to find the mass of the block of wood to the nearest 0.01 gram. $M =$ _____
2. Use the ruler to find the volume of the block of wood to the nearest 0.1 cm^3 .

Indicate on the diagram each measured length.



Calculation of volume:

$$V = \underline{\hspace{2cm}}$$

3. Calculate the density of the block of wood in g/cm^3 to 0.1 g/cm^3 .

Density of wood: _____

B: Block of Lead

- Use the balance to find the mass of the block of lead to the nearest 0.01 gram. $M =$ _____
- Use the ruler to find the volume of the block of lead to the nearest 0.1 cm³.

Draw a diagram of the lead block indicating each measured length.

Calculation of volume:

$V =$ _____

- Calculate the density of the block of lead in g/cm³ to 0.1 g/cm³.

Density of lead: _____

Compare your experimental value with the accepted value of 11.3 g/cm³.

$$\% \text{ Difference} = \frac{|X_{meas} - X_{accepted}|}{X_{accepted}} * 100$$

% difference: _____

C: Density of Water (please show all calculations)

- Find the mass of the graduated cylinder to the nearest 0.01 gram. $M =$ _____
- Pour the water into the graduated cylinder and read its volume to the nearest 0.1 cm³. $V =$ _____
- Combined mass of the graduated cylinder with the water to the nearest 0.01 gram. $M =$ _____
- Calculate the mass of the water to the nearest 0.01 gram.

$M_{\text{water}} =$ _____

5. Calculate the density of water in g/cm^3 to 1 decimal place.

Note: $1 \text{ cm}^3 = 1 \text{ ml}$

Density of water: _____

Part 2: What are pennies made of?

1. Find the mass of the penny to the nearest 0.01 gram. _____
2. Find a way to measure the volume of the penny to the nearest 0.1 cm^3 and write the procedure below:

3. Calculate the density of the penny in g/cm^3 to 1 decimal place.

Density of penny: _____

For your penny, compare your calculated density to those metals in the table below.

Metal	Density (g/cm^3)
Gold	19.3
Copper	8.9
Aluminum	2.7
Zinc	7.1
Iron	7.9

Density of your penny: _____

What metal does your data indicate for the probable composition of a penny? _____

Visit the US Mint's website at

http://www.usmint.gov/about_the_mint/index.cfm?action=coin_specifications to determine the composition of a penny.

What metal(s) does the US Mint use to make pennies? What is the % composition?

Part 3: 'Order of Magnitude' Measurement and Calculation:

In some cases it is only important to have an 'order-of-magnitude' or 'ballpark' estimate of a quantity. For example: How many peanut m&m's would it take to fill up this classroom, assuming the room is empty? We don't really care about the *exact* number of m&m's; we just want to know a 'ballpark' figure.

Before you and your lab partners make any measurements, write down an educated guess as to the number of m&m's required. (i.e., is it hundreds, thousands, tens of thousands, millions, 10^7 , 10^8 ...)

Your guess: _____

Now think of a strategy along with some measurements that will help you with this problem. You may have to make some approximations. In the space below, clearly explain the strategy used, measurements taken, and calculations.

Calculated estimate of the # of m&m's to fill the room: _____

Check with the other lab groups in the room to compare answers.

Please make sure that you have shown all calculations required in this lab.

Conclusion and Summary of Results:

Write a brief conclusion, including a brief discussion of the physics involved in this experiment, including possible sources of error, and indicate whether your results give support or validate the purpose of the lab exercise.