Name: _____ **Period: _____**	**Date: _____**
PreAP Physics	**Daily Work ★ Weight = 1**

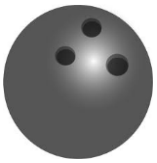
MEASUREMENT & UNIT CONVERSION LAB

TEK: . Scientific measurement
1. Select/use appropriate S.I. units & prefixes to express measurements for real-world problems.
   a. Know common S.I. prefixes (pico to tera), their abbreviations, and their associated powers of 10.
   b. Use S.I. base units (e.g., kilograms, meters) and derived units (e.g., liters, joules, grams per cubic centimeter, etc.)
   c. Understand the relationship and usage of S.I. and standard English units in daily measurements.

DIRECTIONS: In groups of two, circulate through all seven stations (labeled by number), not necessarily in order, to collect the measurements you need. Many stations have two sub-stations set up with virtually identical equipment to help cycle the groups through faster. All the measuring equipment you will need to complete the lab is in the back too. One lab report per person must be turned in. Collect all measurement data first and then sit down at your desks to do the calculations. Each blank is worth one point unless otherwise specified.

PURPOSE: The purpose of this lab activity is to practice:
- estimating measurements
- using a measuring tape, meter stick, ruler, Vernier caliper, micrometer, beaker, & graduated cylinder
- choosing an appropriate measuring device for a certain measuring task
- choosing appropriate units of measurement
- converting between units of measurements
- use derived formulas to verify measurements obtained

STATION 1 WRAPPING You work at Amazon™ and are selling bowling balls and want to wrap them as cheaply as possible using, if sufficient, just three sheets of recycled paper and tape. Do the three pieces of paper have enough surface area to cover the whole bowling ball? Verify this by:



A. _____ **(one point)** Finding the surface area of the bowling ball (**HINT:** surface area of a bowling ball is $SA = 4\pi r^2$)

SHOW YOUR WORK FOR CREDIT:

B. _____ **(one point)** Finding the surface area of the three pieces of paper (**HINT:** area of a rectangle is length × width = l × w)

SHOW YOUR WORK FOR CREDIT:

C. (one point) Are three pieces of paper enough? □ **YES** □ **NO**

.

STATION 2 PACKAGING. Amazon™ again! Retro horseshoe magnets have become all the rage after Beyoncé sported an outfit with them on it (if fidget spinners went viral then…). You are working on a foam mold to package the horseshoe magnet for shipping purposes. To calculate your waste, you need to know how much foam will be carved out of the mold for each magnet. You decide to find the volume of the horseshoe magnet. Use only the materials available at the table.

EXPLAIN/ILLUSTRATE HOW YOU FOUND THE VOLUME HERE (5 pts):

_____

_____

_____

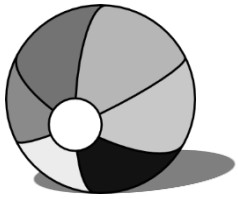
_____

_____

_____

What is the volume of the horseshoe magnet? _____ in cm^3 **(one point)**

STATION 3 SENIOR PRANK. For a senior prank, you decide to fill up Room 205, the physics classroom, with beach/soccer balls. How many beach/soccer balls would you need? Pick either a beach ball or a soccer ball.



HINT: you need to find the volume of the room and the volume of a beach ball.

Volume of the room (assume it is empty): _____ m^3 **(one point)**

Volume of the beach/soccer ball: _____ m^3 (**HINT:** The volume of a sphere is $V = 4/3 \cdot \pi \cdot r^3$) **(one point)**

Two reasons why this estimation method is not going to be too accurate? **(two points)**

Reason 1: _____

Reason 2: _____

Number of beach/soccer balls needed for prank? _____ **(one point)**

SHOW WORK FOR CREDIT:

STATION 4: LEGIT OR SHOULD YOU SPLIT?

BACKGROUND: You own a pawn shop in San Marcos. A dizzy dame walks in and says she has a 24 K gold ring she wants to pawn. You are suspect about the purity of the gold. Your customer says to weigh the ring and compare its weight to an ingot of gold…but you are wondering if that is like comparing apples and oranges.

(one point) To ensure that the ring is pure gold, its _____ (in gm/cm^3) NOT its weight needs to be found, in other words, how much the gold weighs *in relation to* the amount of space it occupies.

DIRECTIONS: Find the density of each coin using the displacement method. Put your information in the table below (each column is one point). NOTE: You may have to use more than one coin to get an easily measurable displacement:

Coin value	Original Volume of Water (in mL)	New Volume of Water (in mL)	Amount of water displaced (in mL)	Mass of coin (in gms)	Density of coin (density = $\frac{mass}{Volume}$)	Value of Density of coin (published value online)	% Error*
Penny							
Nickel							
Dime							
quarter							
Dollar							

* % Error = $\frac{Theoretical\ Value - Experimental\ Value}{Theoretical\ Value} \times 100$

Give two reasons for differences between your answers for density and those published **(one point each):**

Reason 1: _____

Reason 2: _____

Were your errors due to a lack of accuracy, a lack of precision, or both? Explain **(two points).**

_____

_____

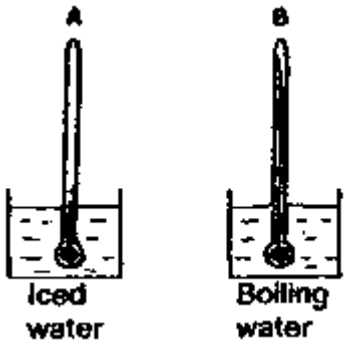
_____

_____

_____

STATION 5: HEATING UP AND COOLING DOWN: ALL THE SAME?

BACKGROUND. When things are hot they cool and when things are cold they heat up. Until what point? Until they reach *thermal equilibrium* with their surroundings. Most of the time the surroundings refers to room temperature.



DIRECTIONS: Measure the initial temperature of the cold water and the hot water. Come back five - six minutes later and measure the final temperatures of the cold and hot water.

Record your results here (one point for each column):

	Initial Temperature (in Celsius)	**Final Temperature (in Celsius)**	**Change in Temp. (in Celsius)**	**Room Temp. (in Celsius)**
Cold water				
Hot water				

(one point) Which changed temperature the most, the cold water or the hot water?

□ **Cold Water** □ **Hot Water**

Why? Both the cold and hot water were in the same room and they had the same amount of water. Both temperatures were measured for the same amount of time. What conclusion can you draw? Why did one change temperature more than the other one? Speculate below **(two points).**

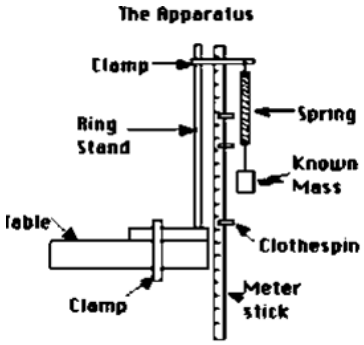
_____

_____

_____

_____

STATION 6: PROPORTIONALITY LAB

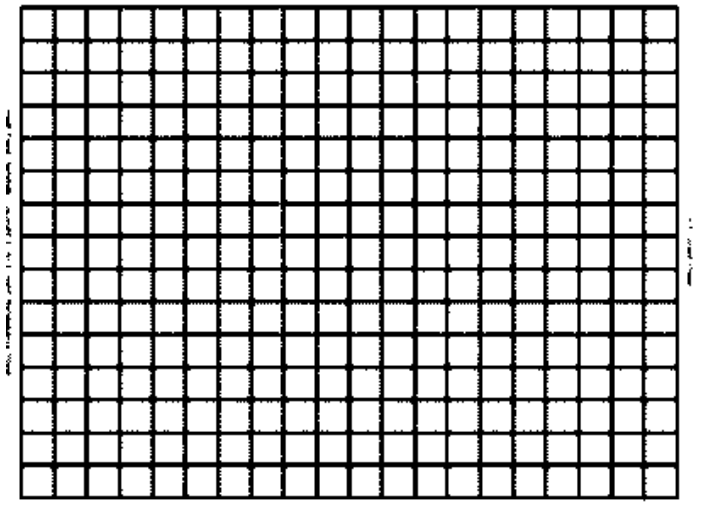


BACKGROUND: We are going to observe a relationship between the mass hung from a spring and the distance the spring stretches.

DIRECTIONS: Hang a weight on the spring hanger. Measure how much the spring stretches. Do the same for three different amounts of weight and record your results in the table below.
Now repeat for a different kind of spring.

	Mass hung		
SPRING 1	**gms**	**gms**	**gms**
Distance stretched	**cm**	**cm**	**cm**
SPRING 2	**gms**	**gms**	**gms**
Distance stretched	**cm**	**cm**	**cm**

(two points) Graph the distance stretched vs. the amount of mass hung from the springs here (Graph two lines, one for each spring). Make sure you label your axes and include the scale.



(one point each) Find the slope of each of your lines and record here.

SLOPE LINE 1 _____ cm/gm SLOPE LINE 2 _____ cm/gm

(two points) What do you think the slope of the lines above represent in real life? In other words, what do they tell you about the springs (**HINT:** look at the units of the slope). _____

_____

_____

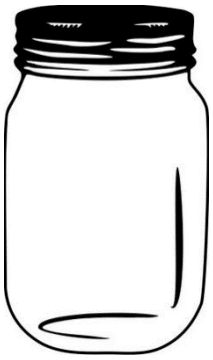
(one point) Is there a direct or inverse proportion relationship between the amount of mass hung and the amount of distance stretched? □ DIRECT □ INVERSE

(one point) Which is the independent variable? □ Weight hung? □ distance stretched?

STATION 7: TEXAS SIZE M&M'S

You are a student entrepreneur and want to raise money for your club or team at SMHS. Everything is bigger in Texas so you decide to sell a Texas-size jar of M & Ms for your fund-raiser but you sure as heck don't want to have to count how many M&M's are in your big jar to figure out how many of each color of M & M you'll need, how much it will cost you, how much you should sell it for, and the nutritional information. Fortunately, you have a "prototype" jar to work with, a small package of M & M's, and measuring equipment (scales, measuring tapes, rulers, graduated cylinders,water, etc.). Answer the questions below to develop your new product:

1. **Describe your strategy in five steps for determining how many M&M's fit in a Texas Sized Jar using the materials and equipment you have available? (15 pts)**



STEP 1:_____

_____

STEP 2:_____

_____

STEP 3:_____

_____

STEP 4:_____

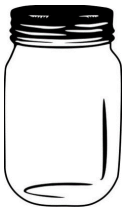
_____

STEP 5:_____

_____

2. How many M&M's are in your sample bag? _____ (5 pts)

3.How many total M & M's are there in the jar? _____(5 pts)



Show your math work for how you determined the total number of M&M's in the Texas Sized Jar in the space below:

4. How many M&M's of each color are in your sample bag? (5 pts)

Orange: _____ Brown: _____
Blue: _____ Red _____
Green: _____ Yellow: _____

5. **How many M&M's of each color are in the Texas Sized Jar? (10 pts)**

Orange: _____ Brown: _____
Blue: _____ Red _____
Green: _____ Yellow: _____

How many total M & M's are there in the jar? _____

Show your math work for how you determined the number of one color of M&M's in the Texas Sized Jar in the space below:

6. What is the weight of the M & M's in your sample bag? (5 pts)

English (pounds): _____ Metric (grams): _____

7. What is the weight of the M&M's in the Texas Sized Jar: (10 pts)

English (pounds): _____ Metric (grams): _____

Show your math work in the space below. How did you find the weight of the M & M's in the Texas Sized jar?

8. a. How many Calories does your sample bag have? _____ (5 pts)

b. How many Calories per serving does your sample bag have? _____ (5 pts)

c. How many servings are in your sample bag? _____ (5 pts)

d. How many M & Ms are there per serving? _____ (5 pts)

9. a. How many Calories does your Texas sized jar have? _____ (5 pts)

b. How many Calories per serving does your Texas sized jar have? _____ (5 pts)

c. How many servings are in your Texas sized jar? _____ (5 pts)

d. How many M & M's are there per serving in your Texas sized jar? _____ (5 pts)

Show your work here:

10. How much does your sample bag cost? _____ (5 pts)

Show your work here.

11. How much should the Texas Size Jar cost to make it comparable to what your customers could get it for on the market? _____ (10 pts)

Show your work here:

12. Accuracy and precision

a. What did you do to ensure that your answer is as ***accurate*** as possible? **(5 pts)**

b. What did you do to ensure that your answer is as ***precise*** as possible? **(5 pts)**

c. Name three possible sources of error in your measurements. **(3 pts)**

Source 1: _____
Source 2: _____
Source 3: _____

(Optional) **Submit a design for your package. (up to 10 bonus pts, based on quality and creativity)**