Name: **Grade:**

GEOL101 LABORATORY – LAB #1 – SCIENCE BASICS

Observing, Measuring, Hypothesizing, Testing, and Units

Introduction & Purpose: In this lab you will observe, measure, hypothesize, and test, earth materials and processes. The purpose of this laboratory experience is to become better familiar with the basic sorts of activities and that geologists do while investigating natural world phenomena as part of scientific inquiries.

Exercise #1 – Scientific Inquiry – Apply Scientific Method to Study a Lava Lamp

Scientists use a special sort of method to undertake all scientific inquiries called the *scientific method*. The scientific method is a sequence of steps that include empirical observations, the formulation and testing of a hypothesis, or tentative explanation, which addresses the origin, evolution, nature and/or processes of natural phenomena.

Directions: Carefully study the glitter and/or lava lamps that are set up in the lab; record as many observations as possible concerning the material, energy, design, and processes of the lamp. Then come up with a central question concerning the nature of the lava lamp. From the question, develop a testable explanation or hypothesis – essentially the 'answer' to your question. Test your hypothesis by devising and running (actually or virtually) an experiment – the analysis of the results of your experiment should allow you to make the following conclusion: ***Yes*** – *my hypothesis is correct*, OR ***No*** – *my hypothesis is incorrect*. Be sure to include the following steps:

Step 1 - **Empirical Observations** - Qualitative & Quantitative descriptions and measurements of system:

a) Material Components– Describe, measure, and sketch (with labels) the whole and separate parts of the system. Include size, shape, form, and make-up of each component and how it spatially relates to the other components – it's "structure". Examples of a component's material make-up are metal, plastic, glass, ceramic, wood, rubber, etc. Be careful to NOT include any explanations, or interpretations in your empirical observations – it should purely based on describing or measuring what you are actually observing.

b) Energy – List the sorts of energy that you detect in the system, including what may be going in or out of the system. Examples are electricity, light, heat, gravitational, kinetic, and magnetic. Be careful here too to NOT include any explanations or interpretations in your empirical observations.

c) Dynamics: Describe and measure notable changes in system through time - changes in mass, energy, temperature, phase change, movement of mass and/or energy. A dynamic system indicates that there are processes occurring within the system and/or between the system and its surrounding environment. Some processes may be observable, whereas, others are not – depending on the available sensing instruments. Movement of matter can be measured by rate of change. Again, be careful to NOT include any explanations or interpretations in describing the system's dynamics.

Step 2 – **Posed Question(s)** concerning the nature of a system (in this lab's case, a glitter or lava lamp) The posed question or problem should have some sort of useful significance, and be well-defined, measurable, and controllable – basically answerable. Questions that are answered by scientific investigation are based on empirical observations - data, and scientific thinking accomplished, usually following previous research.

Step 3 – **Hypothesis** – Interpretation, explanation, and/or prediction of the system. Note that the hypothesis should be stated in a form that basically answers the above posed question(s). A hypothesis may include prediction(s), based on the assumptions made in the hypothesis. A scientific hypothesis must be falsifiable, meaning that it can be tested for validity within the empirical constructs of the natural world, i.e., the hypothesis is scientifically testable. Supernatural explanations are NOT testable.

Step 4 - **Test** – A definitive method/means of finding out whether or not the hypothesis is true or false. The test can be either, an experiment done on the system, or further observations of the system that are used to test a prediction of the future state of the system. In either case, the result should provide a straight-forward conclusion that is either a "**yes**" or "**no**" to the hypothetical answer (hypothesis) to the original posed question(s) made in step 1. Predictions can also be tested by further observation.

Step 5 – **Results** - The measured and recorded observations and information from the test and/or predictions, whether it be from an experiment - the experimental data, or from further observations of the system. Analysis and evaluation of the data will lead to a conclusion concerning the hypothesis.

Step 6 - **Conclusion** - A statement that summarizes the evaluated results (data) from the test. The conclusion will either *invalidate* the hypothesis and prediction(s), or *confirm* the hypothesis and predictions. It is also possible that your results are inconclusive (neither a "yes" nor "no") – this result basically means that your test was inadequate.

Step 7 – **Reevaluation** - Based on your conclusion, what must be done concerning your original hypothesis? Retain it? Modify it? Throw it out completely? Or does it appear that the test does not adequately challenge the hypothesis?

Scientific Inquiry of a Glitter and/or Lava Lamp -- Worksheet

Step 1 – Qualitative and Quantitative Observations of System:

a) Material Components:

b) Energy:

c) Dynamics

Step 2 – Posed Question Concerning System:

Step 3 – Tentative Hypothesis:

Step 4 – Method of Testing: An “experiment” – and/or – Further observations for predicting

Step 5 - Test Results (recorded data):

Step 6 – Conclusion(s):

Step 7 - Reevaluation:

EXERCISE #2 - Determining the Density of Water

Directions: a) Write a simple step-by-step procedure on how you could use a small graduated cylinder and a gram balance (scale) to determine the density of water by dividing its measured mass by its measured volume, in grams per cubic centimeters (g/cm^3). **b)** Use your measurements of water's mass and volume to calculate the density of water as accurately as you can. Note: You must show your complete calculations **and units** for full credit.

Step 1.____

____

Step 2. ____

____

Step 3. ____

____

Step 4. ____

____

Water Sample Measurements: **Water Mass =** ______ grams **Water Volume =** _______ milliliters

Write Calculations for Water Sample Below: Note: ***Density = Mass ÷ Volume*** (don't forget units)

Write Your Calculated Value for Water Sample Density Here: _________

Question 1). Do you see any significance in your calculated value of water density, in terms of how the concept of the mass value of "1 gram" was developed? Hint: What material of what volume under what conditions did the global scientific community agree on to use as a standard mass to define the unit of EXACTLY 1 "Gram"? Why do you think they agree on this definition of "gram"?

Question 2) If you measured a chuck frozen water (ice), and it had the same weight as your liquid sample you measured above, could you predict whether it would have a different volume, based on personal experience? How might you test your prediction?

EXERCISE #3 – CONVERTING UNITS OF MEASUREMENT

Directions: Calculate the following unit conversions using the correct significant place values. The unit conversion values are found on the last age of this worksheet. Note that you **MUST** show your math calculation AND units to get credit for your answer.

Unit Conversion Problem	Unit Conversion Calculation
Example: 2.5 miles = _4.0_ kilometers	2.5 mi x 1.6 km/mi = 4.0 km (miles cancel)

a. 10.0 miles = _______ kilometers.

b. 3.0 feet = ______ meters.

c. 16 kilometers = ______ meters.

d. 25 meters = ______ centimeters (cm).

e. 1.3 liters (L) = ______ milliliters (mL) or cubic centimeters (cm^3)

f. 25.4 mL = ______ cm^3

g. 120 pounds = ______ kilograms (Kg).

h. 2 ounces = ______ . grams

i. If an object traveled 280 miles in 4 hours, the velocity of the object = ________ km/hr

Velocity = distance÷ time

j. Convert your height from Imperial System to Metric System. (convert feet/inches to centimeters)

My height is ___ feet ____ inches. My height in cm's is ______ cm.

k. Convert your weight from Imperial System to the Metric System. (convert pounds to kilograms)

My weight is ________ lbs. My weight in kg is ______ kg.

n. Convert the following temperatures from Fahrenheit to Celsius. Conversion: C = (F - 32) x 5 ÷ 9

Average human body temperature is 98.6˚ F = _______˚C

Exercise #4 - Written Laboratory Reflection

Directions: Write a 120 word minimum reflection of the lab activity, explaining its purpose, the methods used, the results obtained, and a brief personal reflection of what you enjoyed and learned about doing this lab (*3 points possible*). Answer the following 3-point question reflection set on a separate sheet of paper:

1) What was the purpose of this lab? What did you actually discover and learn during this lab?

2) What did you enjoy most about this lab? Also, what was challenging or thought-provoking?

3) What are your constructive comments about the design and execution of this lab? What's good? What's bad? Offer suggestions for making the lab better.

APPROXIMATE CONVERSIONS FROM ENGLISH UNITS TO SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY (CF)**	**TO FIND**	**SYMBOL**
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
^oF	Fahrenheit	5 (F-32) ÷ 9	Celsius	^oC