**Part 1: Measuring Mass**

**Mass** is a basic property of all matter (stuff in nature). All matter is made up of microscopic particles called *atoms* and *molecules*. The mass of an object is a measure of the number of particles in the object and the types of particles in the object. The unit of measurement for mass is grams (**g**) or kilograms (**Kg**).

1. Based on what you learned from the *Particle Theory Presentation*, which has more particles: 10g of oxygen gas, 10g of liquid oxygen, or 10g of frozen oxygen?

1. Complete the *Particle Theory Worksheet* and attach it to you density lab report.

**Weight** and mass are often confused in common speech. On Earth, weight of an object is due to both its mass and gravity. In space, where there is little or no gravity, an object may be weightless but will still have all of its mass.

1. Which of your objects has the greatest weight?
2. In space, will the mass of your objects increase, decrease or stay the same?

**Beam Balance:** Write a procedure and provide a diagram for measuring the mass of an object using a beam balance.

**Electronic Scale:** Write a procedure and provide a diagram for measuring the mass of an object using an electronic scale.

**Data Table: Mass of Objects**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Object & Description** | **Beam Balance #1**  **(Mass in g)** | **Beam Balance #2**  **(Mass in g)** | **Electronic Scale**  **(Mass in g)** | **Average Mass**  **(g)** |
| Object #1 |  |  |  |  |
| Object #2 |  |  |  |  |
| Object #3 |  |  |  |  |

**Precision** of a measuring device such as a balance or a scale is related to the number of digits or decimal places it provides when measuring a quantity such as mass. A device with more precision provides more digits or decimal places.

1. Which device that you used to measure the mass of your objects provided the most precision?

**Accuracy** is related to the correctness of device and how well measurements can be repeated. Note that just because an device provides more digits (is more precise) it does mean it is more accurate. A device may be working well but if it is not properly adjusted it will not be accurate and will give incorrect measurements.

1. Explain how to adjust the accuracy of a beam balance?
2. List the difficulties you had or could have in the future when using the beam balance to measure mass.
3. Explain how to adjust the accuracy of the electronic scale?
4. List the difficulties you had or could have in the future when using the electronic scale to measure mass.
5. Which device that you used to measure the mass of your objects provided the most accuracy? How do you know?

**Part 2: Measuring Volume**

**Volume of a Regular Solid** such as a cube or rectangular prism can be calculated using a formula such as:

Volume = Length x Width x Height

Volume is measured in cubic centimeters (cm3) for solids or milliliters (ml) for liquids. The measurement of 1 cm3 is the same as 1 ml.

**Calipers** are a special device for measuring the dimensions of a solid object. When available, the use of calipers provides greater accuracy and precision than the use of a ruler.

1. Write a procedure and provide a diagram for measuring the dimensions of an object using calipers.

**Data Table: Volume of Regular Solids**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Object & Description | Using a Ruler | | | | Using Calipers | | | |
| Length (cm) | Width (cm) | Height (cm) | Volume (cm3) | Length (cm) | Width (cm) | Height (cm) | Volume (cm3) |
| Object #1 |  |  |  |  |  |  |  |  |
| Object #2 |  |  |  |  |  |  |  |  |
| Object #3 |  |  |  |  |  |  |  |  |

**Volume Using the Displacement Method** is most useful for irregularly shaped objects but can be used for any solid object that fits inside container of a liquid such as water. The method is based on the fact that an object will raise the level of the liquid water that is equal to the volume of the solid object when completely submerged. A ***graduated cylinder*** is used in science to accurately measure the volume of liquids.

1. Write a procedure and provide a diagram for measuring the volume of a liquid using the ***meniscus*** of a graduated cylinder.

**Volume Using the Overflow Method** is a variation of the displacement method that is used when the object to be measured is too big to fit directly in the graduated cylinder.

1. Write a procedure and provide a diagram for measuring the volume of a liquid using an ***overflow can*** and a graduated cylinder.

**Data Table: Volume of Irregular Solids**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Object & Description | Using a Displacement Method | | | | Using Overflow Method | | | |
| Before (ml) | After (ml) | Change (ml) | Volume (ml) | Trial 1 (ml) | Trial 2 (ml) | Trial 3 (ml) | Average (ml) |
| Object #1 |  |  |  |  |  |  |  |  |
| Object #2 |  |  |  |  |  |  |  |  |
| Object #3 |  |  |  |  |  |  |  |  |

1. List the difficulties you had or could have in the future when using the ***displacement method*** to measure volume.
2. List the difficulties you had or could have in the future when using the ***overflow method*** to measure volume.

**Part 3: Calculating Density**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Density** is a physical property of matter and depends on the type of particles that make up the material or type of matter.  A type material has a unique density which can be used to identify and tell the difference between similar looking materials. For example, jewelers use density to tell fake gems from real gem stones.   1. A woman wants to sell her diamond ring. The jeweler find the density of the stone in the ring to be 2.5 g/cm3. Should the jeweler buy the ring from the woman? | **Density of Common Materials**   |  |  | | --- | --- | | **Material** | **Density (g/cm3)** | | Air | 0.0012 | | Styrofoam | 0.075 | | Wood | 0.700 | | Ice | 0.917 | | Oil | 0.942 | | Water | 1.000 | | Plastic | 1.175 | | Glass | 2.500 | | Aluminum | 2.700 | | Diamond | 3.500 | | Zinc | 7.000 | | Steel | 7.830 | | Nickel | 8.900 | | Copper | 8.940 | | Lead | 11.340 | | Gold | 19.320 | |

Materials are also chosen by their density for different special applications. Lead, for example, is used to shield patients and doctors from harmful x-rays because of its very high density of 11.340 g/cm3.

1. Would gold be a good choice to shield people from harmful x-rays? Explain your answer.

Density may be calculated using a simple equation. Based on the Density Presentation given by your teacher, write the three rearrangements of the density equation below.

|  |  |  |
| --- | --- | --- |
| Density = | Mass = | Volume = |

1. Complete the *Density Worksheet* and attach it to you density lab report.

**Density Calculations:** Complete the table below for your sample materials.

|  |  |  |  |
| --- | --- | --- | --- |
| **Object & Description** | **Average Volume (cm3)** | **Average Mass (g)** | **Calculated Density (g/cm3)** |
| Object #1 |  |  |  |
| Object #2 |  |  |  |
| Object #2 |  |  |  |

**Density Predictions:** Use the table at the top of the page to predict the material of each of your objects.

* 1. Material:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Reason: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  2. Material:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Reason: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  3. Material:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Reason: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 4: Density of a Liquid**

**Liquid and a gas** states of matter also have densities that can be measured and calculated. The density of a liquid and a gas is almost always less that the density of a solid of the same type of matter.

**Ice and water** are an important exception to the rule. Water is almost the only substance where its solid form (ice) is less dense than its liquid form (water). This unique property makes life on Earth possible.

1. The density of water = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ The density of ice = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Why does this property of water make life possible on Earth? Think about what happens to Oceans, lakes, and rivers during the winter while composing your answer.

Follow the procedure described by your teacher for calculating the density of a liquid to determine the density of oil and the density of water.

**Data Table: Density of Oil and Water**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Trial Number** | **Volume  (Measured ml)** | **Mass of Empty**  **Cylinder (g)** | **Mass of Liquid & Cylinder (g)** | **Mass of Liquid (Calculated g)** | **Density (Calculated g/ml)** |
| Water: Trial #1 |  |  |  |  |  |
| Water: Trial #2 |  |  |  |  |  |
| Water: Trial #3 |  |  |  |  |  |
|  |  |  |  |  |  |
| Oil: Trial #1 |  |  |  |  |  |
| Oil: Trial #2 |  |  |  |  |  |
| Oil: Trial #3 |  |  |  |  |  |

Compare the results of your experiment with the published density values provided in the table on page 5.

* Experimental Average density of Water: \_\_\_\_\_\_\_\_ Published density of Water: \_\_\_\_\_\_\_\_
* Experimental Average density of Oil: \_\_\_\_\_\_\_\_ Published density of Oil: \_\_\_\_\_\_\_\_

**Oil Spill Cleanup Research**

Your task is to research on-line about industrial oils spills and the methods used to clean up the environment. You will produce a one page written report to attach to this Density Lab. Your report must include the following:

1. A prediction of what happens when you mix oil and water. Will the oil float on top, will the water float on top, or will they stay mixed? Your prediction must make use of the results of your experiment above.
2. A description of a specific industrial oil spill accident including: what happened, where did it happen, when did it happen, and what were its effects on the environment.
3. An explanation of the methods used to clean up oil spills and how the physical property of density is used in these methods.

**Part 5: Is A Nickel Coin Made Of Nickel?**

Your task is to design and carry out an experiment to determine the type of metals used in Canadian coins.

Your experiment must make use of the procedures for measuring volume and mass and for calculating density covered in this density lab activity.

Your experiment should also include a question, hypothesis, and conclusion section based on what you learned in the whirlybird activity.

Your experiment must include the following details:

* Verification that Canadian nickels are made of nickel
* Prediction of the type of metal used in ***old*** Canadian pennies (prior to 1980)
* Prediction of the type of metal used in ***new*** Canadian pennies (after 2000)
* ***Note***: The use of multiple coins of the same type will improve your accuracy.   
  Use of just one coin will have a too small mass and volume for good results.

You must also answer the following ***extra two questions*** in your conclusion section:

1. Does the density of an object depend on the volume of the object? For example: If two objects are made out of the same type of material, will the larger object have a greater density?
2. Does the density of an object depend on the mass of the object? For example: If two objects are made out of the same type of material, will the larger object have a greater density?

**Checklist**

|  |  |
| --- | --- |
| **Check** | **Assignment Item** |
|  | Completed Density Lab handout (all questions answered, all data tables complete) |
|  | Particle Theory Worksheet attached (see page 1) |
|  | Density Worksheet attached (see page 5) |
|  | Oil Spill Research attached (see page 6) |
|  | Question for Canadian Coin experiment |
|  | Hypothesis for Canadian Coin experiment |
|  | Measurement of volume for nickel coin |
|  | Measurement of mass for nickel coin |
|  | Calculation of density for nickel coin |
|  | Measurement of volume for new penny |
|  | Measurement of mass for new penny |
|  | Calculation of density for new penny |
|  | Measurement of volume for old penny |
|  | Measurement of mass for old penny |
|  | Calculation of density for old penny |
|  | All measurements and calculations neatly recorded in data table(s) format |
|  | 3 trials and averages recorder in data table(s) format |
|  | Conclusion Section: Verification of nickel material with explanation |
|  | Conclusion Section: Prediction of type of material for new pennies with explanation |
|  | Conclusion Section: Prediction of type of material for old pennies with explanation |
|  | Conclusion Section: Answers to two extra questions (see page 7) |
|  |  |