Density is a beautiful relationship between mass and volume that can be used in many different ways. Three are outlined below…

1. Density gives clues as to what a given same is made of (or not made of) and or how it is put together at a microscopic scale. If a substance is all the same stuff, the density should match the standard density of the pure substance.
2. It can be used to find the mass when you know the volume or the volume when you know the mass.
3. It can be used to predict the behaviors or interactions of different materials such as floating. For example: will a certain type of matter float in a given fluid (liquid or gas), like Ice in water, rocks in water, oil and water or other liquids.

**Density Calculations Worksheet I**

$Density= \frac{Mass}{Volume}$ in units of $\frac{g}{mL} or\frac{g}{cm^{3}}$ really since $1mL=1cm^{3}$ they are the same unit…

The units for Density are a mass or weight unit divided by a volume unit. Most often they are given as **grams for every milliliter** (g/mL) for liquids because mL is most commonly used for measuring liquid volume. You will also see **grams for every centimeter cubed** (g/cm3) sometimes for solids because solids are often measured in a cubic length (Length x width x height, or cm x cm x cm= cm3)

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| --- | --- | --- | --- | --- | --- |
| **Solids****(Metals)**  | **Density g/cm3  (g for every cubic Centimeter)**  | **Liquids** | **Density g/mL (g for every milliliter)** | **Gases** | **Density g/mL (grams for every milliliter)** |
| Aluminum  | 2.70  | Distilled water | 1.000 | Hydrogen | 0.0008988 |
| Copper  | 8.96  | Tap Water | 0.9995 | Helium | 0.0001786 |
| Gold  | 19.32  | Sea Water | 1.027 | Argon | 0.001784 |
| Iron  | 7.87  | Ethanol (2 carbons) | 0.7893 | Carbon monoxide | 0.001145 |
| Platinum  | 21.45  | Propanol (3 carbons) | 0.8035 | Carbon Dioxide | 0.001977 |
| Steel  | 8.05  | Butanol 4 carbons) | .8100 | Air | 0.001225 |
| Zinc  | 7.13  |  |  |  |  |

Table 1. Standard Values for Density of selected substances.

If you have any 2 of the 3 measurements, you can calculate the missing value. Here are 3 mystery substances find the missing measure.

Example 1: Mass = 132 g Volume = 60 ml Density = \_\_\_\_\_\_\_\_\_\_\_\_

Example 2: Mass = \_\_\_\_\_\_\_\_\_\_\_ Volume = 45 ml Density = 55 g/ml

Example 3: Mass = 135 gm Volume = \_\_\_\_\_\_\_\_\_\_\_\_ Density = 15.75 g/cm3

1. For the following masses and volumes, calculate the densities, give the identity of the substance, and your reasoning.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number | Mass (g) | Volume (cm3) | Density (g/cm3) | Substance |
| 1 | 3.25g | 4.04 cm3 |  |  |
| 2 | 8.98g | 11.09cm3 |  |  |
| 3 | 2.15g | 0.240cm3 |  |  |
| 4 | 5.16g | 2610cm3 |  |  |
| 5 | 4.42g | 0.620cm3 |  |  |

1. Calculate the unknown Quantity.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number | Mass (g) | Volume (cm3 or mL) | Density | Substance |
| 1 | 56.25 g | 69.44mL |  |  |
| 2 |  | 5000.0mL |  | Hydrogen Gas |
| 3 |  | 355mL | 0.7893 |  |
| 4 |  | 35cm3 |  | Steel |
| 5 | 16.25g |  |  | Gold |

1. Find the unknown quantity:

|  |  |  |
| --- | --- | --- |
| You have 13.00 grams of aluminum, how much volume do you have in g/cm3? (Hint- use table of densities)  | If you have 45.6mL of a liquid and its mass is measured at 46.83g, what is its density? What liquid is it? | If you have 2000mL of Carbon Dioxide, what is the sample’s mass? (Hint- use table of Densities) |

**WORD PROBLEMS**

1. A block of aluminum occupies a volume of 15.0 mL and weighs 40.5 g. What is its density? Does this match the Standard value from the table?
2. Mercury metal is poured into a graduated cylinder that holds exactly 22.5 mL. The mercury used to fill the cylinder weighs 306.0 g. From this information, calculate the density of mercury.
3. What is the mass of the ethanol that exactly fills a 200.0 mL container? The density of ethanol is 0.789 g/mL.
4. A rectangular block of copper metal weighs 1896 g. The dimensions of the block are 8.4 cm by 5.5 cm by 4.6 cm. From this data, what is the density of copper? (hint: find the volume of a block first)
5. Find the mass of 250.0 mL of benzene. The density of benzene is 0.8765 g/mL.
6. A block of lead has dimensions of 4.50 cm by 5.20 cm by 6.00 cm. The block weighs 1587 g. From this information, calculate the density of lead.
7. If 28.5 g of iron shot (little pieces, like BBs or pebbles) is added to a graduated cylinder containing 45.50 mL of water. The water level rises to the 49.10 mL mark, from this information, calculate the density of iron.