Benson Long

Chemistry 113.1

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**Experiment 1: Density**

**Abstract:**

Density is equivalent to the ratio of mass over volume and can contribute to identifying what an unknown substance is. We measured the density of regularly shaped objects or cylinders and found the density to be most similar to polyvinyl chloride. We also measured the density of an irregularly shaped object or mineral and found it to be most similar in density to the amazonite, a mineral that is turquoise and white. Lastly, we found the density and V% of ethanol mixed with water and created a graph charting V% to identify the two unknown mixtures. The two unknown mixtures, Aliquot #1 and #2, turned out to have V% of 100% and 50% respectively.

**Introduction:**

Extensive properties are measured in quantity and examples are mass and volume. They are used to find intensive properties such as density. Intensive properties can be useful in identifying what a substance is because substances tend to have specific intensive properties while many materials can share the same extensive properties. This is not to say that intensive properties can definitely identify what an unknown substance is alone. More data would be required in order to correctly find out what the unknown substance really is.

Specifically, density is the ratio of the mass and volume of a particular object or substance. The mass is the weight of the object which is measured in grams or kilograms. Volume is amount of space a particular object takes up and is measured in milliliters or cubed centimeters. The formula for density is: p = m / V where p is the density, m is the mass, and V is the volume.

**Experimental:**

For regularly shaped objects, we measured the diameter and height of the cylinders and calculated the volume using the formula: V = pi \* r2\* h. From there, we calculated the density for each cylinder and found the mean of the values. We then graphed the values and identified what the cylinders are based off their density values.

For irregularly shaped objects, we submerged minerals under water and use water displacement to measure the volume of the mineral. From there, we used the volume and mass of the sample to calculate the density. We then used the density value to identify what the mineral was.

For the density of liquids, we measured the volume of alcohol and weighed the alcohol. We added water to the alcohol and remeasured and rerecorded the volume and weight of the new mixture. From these values, we found the density and then found the V% of each mixture and created a graph to find what the V% of unknown mixtures were based off of their densities.

Materials:

Ruler, electric balance, 100mL graduated cylinder, beakers, set of four cylinders, one unknown object and ethanol.

**Results:**

**Table A: The dimensions and mass of each object**

Sample Code: E01A29

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Object | Diameter (cm) | Length or Height (cm) | Mass (g) | Volume (cm3) | Density (g/cm3) |
| A | 1.6 | 2.3 | 6.313 | 4.624 | 1.365 |
| B | 1.6 | 3.8 | 10.365 | 7.640 | 1.357 |
| C | 1.6 | 5.3 | 14.325 | 10.656 | 1.344 |
| D | 1.6 | 6.7 | 18.164 | 13.471 | 1.348 |

**Mean = 1.354**

p = m / V.

p = 18.164 / 13.471 = 1.348

The regular shaped objects’ densities are between the densities of two known materials of 1.32 and 1.37. The mean density measurement is equal to 1.354 which is closer to 1.37 and is therefore identified as polyvinyl chloride.

**Table B: Density of Irregularly shaped objects**

Sample Code: U-B2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| M (g) | [Vi (H2O)] (mL) | [Vf (H2O)] (mL) | Vmineral (mL) | Density (g/cm3) |
| 6.603 | 30.0 | 33.0 | 3.0 | 2.201 |

p = m / V.

p = 6.603 / 3.0 = 2.201.

The mineral with the density closest to 2.201 is 2.36. However, the description does not match the observations I took of the mineral. I observed the mineral to be turquoise with white and the tentative ID is amazonite with a density of 2.58. The percent error is [(2.58 – 2.201) / 2.58] \* 100 = 14.69%.

**Table C1: Volume of alcohol, volume of added water, total volume, total mass and volume percent alcohol**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sample | Valcohol | Vwater added | Vtotal | Mass total | V%alcohol | Density (g/mL) |
| 1 | 2 mL | 0 mL | 2 mL | 1.380 | 95% | 0.69 |
| 2 | 2 mL | 1 mL | 2.6 mL | 2.109 | 73.07% | 0.81 |
| 3 | 2 mL | 3 mL | 4.2 mL | 3.847 | 45.24% | 0.92 |
| 4 | 2 mL | 5 mL | 6.2 mL | 5.692 | 30.65% | 0.92 |
| 5 (water only) | 0 mL | 2 mL | 2 mL | 1.814 | 0 % | 0.9 |

**Table C2: Volume and mass of two aliquots of alcohol/water mixture of unknown V%**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Volume | Mass | Density (r) | V% |
| Aliquot #1 | 3 mL | 1.952 g | 0.65 g/mL | 100% |
| Aliquot #2 | 3 mL | 2.591 g | 0.86 g/mL | 50% |

p = m / V.

2.591g / 3 mL = 0.86 g / mL.

According to the graph for V% and Density, the V% of Aliquot #1 is 100% and the V% of Aliquot #2 is 50%. There is some uncertainty because the lowest known density value is 0.69 but the density of Aliquot #1 is 0.65. Therefore, we have to extend the line and make an educated guess what V% value we get from 0.65 g/mL. The Aliquot #2 has a density value of 0.86 and comparing it to the straight line fit, it reaches a point on the line that is aligned with a V% of 50%.

**Conclusion:**

This experiment was about learning how to measure the density of various objects and substances using different methods of measurement. We measured the densities of objects using geometry to the find volume, using water displacement to find volume, and using graphs to compare densities and find the equivalent V%. Ultimately, density is seen in all sorts of mixtures, chemicals and most commonly water. Density can be used in a variety of experiments to calculate other values and is found in the periodic table of elements. The techniques we learned from this lab are important concepts in chemistry and allow us to better understand one of the fundamental units of chemistry density which will eventually help us to understand more complex ideas in chemistry.