##### The following is a model of the formal lab report. Students may NOT copy and paste this as their own lab report, but use it as a guide for writing lab reports.

##### Student Name Physics

*Date Teacher, Day / Time*

##### Density // Physical & Chemical Changes

**Introduction** This lab deals with properties of matter.

**Purpose** To utilize an intensive property (density) in order to identify various materials and to investigate the difference between physical and chemical changes.

**Background Information**

Density is the mass (amount of matter an object has) divided by its volume (the amount of space the object occupies). It is an intensive property because density can be used to identify or distinguish between substances. Objects will be identified based on accurate measurement of mass and volume to determine the density of each object and compare that to a standardized table.

All substances undergo changes and when a new substance is formed, this indicates a chemical change. Bubbles (gas formation), color change, and formation of a precipitate are often equated with a chemical change, but physical changes can also exhibit those same changes. The determining factor between a physical and chemical change is whether a new substances is formed with its own properties, different from the properties of the individual elements or substances that comprise the substance.

**Hypothesis**

When one measures the mass and the corresponding volume of a substance, one should be able to identify that substance. In this lab, water, alcohol, plastic, copper should be easily identified using density. We predict that we can identify all substances correctly.

When observing changes in substances, one should recognize whether the change was physical or chemical based on evidence that shows whether a new substance is produced (chemical change). We predict that we can identify 10 out of the 13 changes correctly in this lab.

**Equipment (Density)**

Metric ruler Overflow Can 100 ml Graduated Cylinder

4 unknown Substances: copper cylinder, water, isopropyl alcohol, plastic cube

**Equipment (Physical & Chemical Changes)**

Piece of Paper Match Pin Big Ballon

250 ml beaker Water Sugar Mortar & pestle NaCl (salt) Small Balloon 3 M HCl Aluminum Foil

Evaporating dish CuSO4 crystals Hot Plate Iron Filings in Test Tube Strong Magnet Vinegar Penny Hydrogen Peroxide

**Procedures** **(Density)**

1. There were four (4) unknown substances that needed to be identified using density.

2. Measure the mass and volume for the unknown and write down the appropriate data for that substance on your Calculations and Data sheet. We needed to vary the approach for finding volume depending on the type of substance you have.

3. Use the calculated data to determine which substance we had, by comparing to the chart:

|  |  |  |  |
| --- | --- | --- | --- |
| Substance | Aluminum | Isopropyl Alcohol | Plastic |
| Density | 2.7 g/cm3 | 0.8 g/ml | 0.1 g/cm3 |

**Procedures (Physical & Chemical Changes)**

4. The teacher showed us a YouTube video of 16 changes. We determined whether the change or property observed was physically or chemically related and recorded this on the Calculations and Data sheet.

a. We used a “P” in the “Physical Change” column to represent a physical change.

b. We used a “C” in the “Chemical Change” column to represent a chemical change.

c. For each change, we gave give evidence for the type of change we observed.

*\*Refer to the lab handout, “Density, Physical & Chemical Changes” for detailed procedures.*

**Calculations and Data Using Density**

**DENSITY TABLE (use the nearest 0.1 for all measurements)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Mass of  grad cyl | Mass of cyl + substance | Mass of substance | Volume (grad cyl) | Volume  (L x W x H) | Density | Identity of Substance |
| 1 | 120.2 g | 126.8 g | 6.6 g | 8.3 ml |  | 0.8 g/ml | Isopropyl Alcohol |
| 2 |  |  | 133.1 g |  | 1092.7 cm3 | 0.1 g/ cm3 | Plastic  cube |
| 3 | 120.2 g | 151.6 g | 31.4 g | 31.1 g |  | 1.0 g/ml | Tap  Water |
| 4 |  |  | 197.8 g | 73.3 ml |  | 8.3 g/ ml | Copper cylinder |

1. For unknown substance #2 … show work for calculating the volume

**Length x width x height = cm3**

2. For unknown substance #4 … how did you determine the volume?

**We used an overflow can and the process of water displacement in ml**

3. Show Work for Calculating the Density of each of the unknowns:

1. unknown #1

**6.6 g / 8.3 ml = 0.8 g/ml**

1. unknown #2

**10.3 cm x 10.3 cm x 10.3 cm = 1092.7 cm3**

1. unknown #3

**31.4 g / 31.1 ml = 1.0 g/ml**

1. unknown #4

**100.0 g / 12.0 ml = 8.3 g/ml**

B. Name the three different techniques utilized in this lab to determine the volume of the unknown substances. What was the metric unit used in each case?

|  |  |
| --- | --- |
| Technique Used | Metric Unit |
| **Length x width x height** | **cm3** |
| **Water displacement** | **ml** |
| **Direct Measurement using a graduated cylinder** | **ml** |

## 

The pictures show finding volume (left) using water displacement and finding mass of a substance (right). For determining the volume we placed an object in the beaker and the water overflowed into a graduated cylinder. To determine the mass we had previously massed the beaker with the water displaced volume. Subtract the mass of the beaker to get the volume of the water alone. This volume represents the volume of the object.

## Calculations and Data Using Physical and Chemical Properties

**PHYSICAL & CHEMICAL PROPERTY TABLE**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Instruction** for Substance | Type of **Change**  (P or C) | Give **evidence** if a chemical change has taken place **or** give the predominate physical property observed |
| 5 | Obtain a small piece of scrap paper and tear it into little pieces | P | *The paper is still paper although smaller in size* |
| 6 | Strike a match so that it lights and extinguish it. Observe the burned end | C | *The match head changed color and new substances were produced (smoke, carbon)* |
| 7 | Add a small amount of sugar to a beaker of water and stir | P | *The sugar simply dissolves but is still sugar* |
| 8 | Use a mortar and pestle to grind a small amount of salt into powder | P | *The salt particles are now smaller, but are still salt* |
| 9 | Fill a balloon and tie it. Use a pin to pop the balloon. | P | *The balloon makes a loud noise and pieces may be spread around … but it is still the same material* |
| 10 | Aluminum foil, 3 M HCl in an Erlenmeyer flask with balloon (*teacher demo*) | C | *A “new” gas was produced (light the balloon with a wood splint on the end of a meter stick) … the acid changed color* |
| 11 | Place a few copper sulfate crystals in an evaporating dish and heat gently | P | *The blue color disappears, but if you add a small amount of water, the blue returns* |
| 12 | Magnetize iron filings and then de-magnetize them | P | *The iron filings are still iron whether it is magnetized or not … the iron is only aligned or misaligned* |
| 13 | Imagine an ice cube melting into a pool of water | P | *Ice is the solid form of water* |
| 14 | Add 2-3 drops of food coloring to a beaker of water | P | *The food coloring changed the color of the water, but it is still water and food coloring … no new substance* |
| 15 | Place ~100 ml of water in a 250 ml beaker. Add an Alka Seltzer tablet. | C | *Alka seltzer produces fizzing which is a “new” gas that was produced that is not water or the original alka seltzer.* |
| 16 | Place ~20 ml of vinegar in a 250 ml beaker. Add a teaspoon of salt and a penny. | P | *The penny became shiny and cleaner, but was still a penny in a salt-vinegar solution* |
| 17 | Add ~20 ml of hydrogen peroxide to the salt-vinegar solution with the penny (#16) | C | *Bubbles were released off the penny; greenish color came off the penny into the solution; the penny started to fade.* |

**Conclusions**

**Hypothesis**

The purpose of this laboratory investigation was to utilize an intensive property (density) in order to identify various materials and to investigate the difference between physical and chemical changes. Using density, four substances were identified after determining the mass and volume of a specific amount of each substance. For example, 6.6 grams of isopropyl alcohol occupied 8.3 ml of space, giving it a density of 0.8 g/ml. We were able to identify all five substances especially since the densities were significantly different.

Several physical and chemical changes were observed and identified based on whether a new substance was formed or not. For example, paper was torn into smaller pieces as a physical change, since the resulting smaller pieces were still paper. However, when aluminum foil was placed in hydrochloric acid, bubbles formed, the color changed, and a violent exothermic reaction (giving off heat) took place, showing a chemical change with a new substance being formed. We predicted 10 or the 13 changes correctly. We did not correctly access the physical change of placing a penny in vinegar because the penny became shinier (we assumed a chemical change). We also thought that magnetism was a chemical change since it is so unique, but it is a physical change. We also thought that the copper sulfate crystals turning greenish white was a chemical change, but when water was added back, the copper sulfate crystals returned to their blue color, indicating a physical change.

**Analysis**

The major concepts in this lab were as follows:

1. **Density** = mass / volume … give an example from the lab

Volume was found using water displacement (irregular solids), L x W x H (regular solids), and by using the graduated cylinder (liquids) … give an example from the lab

2. **Physical** versus **Chemical** changes (chemical changes form a NEW substance). Give an example of each change from the lab.

3. **Intensive** properties (used to identify substances … density) … give an example from the lab.

**Extensive** properties (how much … mass, volume) … give an example from the lab

**Questions**

(*Do NOT copy and paste the questions … they are shown here because you did not actually have this lab*)

1. What kind of quantifying properties are mass, weight and volume?

*Quantifying properties are mass, weight and volume. These are extensive physical properties that indicate “how much” of a substance one has. For example, we determined the mass of the substances in the density procedures using a triple beam balance. The copper cylinder had a mass of 100.0 grams.*

2. What kind of quantifying property is density? How is this kind of property different than those in question #1?

*Density is an intensive physical property which is used to IDENTIFY substances rather than just indicate how much of a substance we have as with extensive physical properties. We calculated the density of one substance to be 0.8 g/ml and when we used the chart of substances, we could easily determine that this substance was alcohol.*

3. What is the most important factor in determining whether a physical change or a chemical change has taken place?

The most important factor in determining whether a physical change or a chemical change has taken place is the formation of a new substance. If no new substance is created or produced, then the change is physical. If a new substance is produced, the change is chemical. For instance, tearing paper did not change the substance itself: it was still paper with a different shape and size. However, when acid was added to the metal, bubbles formed, color changed and a violent reaction occurred, indicating a chemical change.

4. Would a color change indicate a physical change or a chemical change? Explain.

A color change can indicate either a physical change or a chemical change. Physical changes commonly involve a color change such as the copper sulfate changing color from blue to white when heated, but back to blue when water was added. This showed that the copper sulfate still existed. Many chemical changes (reactions) also involve color changes. For instance, when the match was lit, the match head changed color from red to black, smoke was given off and a lot of heat. The match was no longer able to light after the reaction, indicating a chemical change.

**Error**

During the density portion of the lab, there was human error related to measurement (volume and mass). One way to reduce the error would be to take several trials of each measurement.

During the physical versus chemical change portion of the lab, human error could occur related to identifying whether a new substance had been produced. For instance, when the penny was added to the vinegar, it became shiny and brighter in color. This color change might mislead one to conclude a chemical change, when it was actually a physical change.

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