Bubbles up: a science experiment on density

Environment, Water

Bubbles Up: A Science Experiment on Density Density is the measure of the quantity of some physical property [usually mass] per unit length, area, or volume (YourDictionary. com). How does temperature affect density? Do items become denser after being frozen? It is well known that water becomes denser when it's temperature lowers until its freezing point. Does this principle apply to oil; and if so, which kinds? This question easily applies to real world problems. For example, when there is an oil spill in the ocean, the clean up crews have to know how dense the oil is before simply cleaning it up. If the oil is dense enough that only very small amounts are rising to the surface, the clean-up team will have to come up with a deep cleaning plan that won't harm marine wildlife. On a more everyday level, understanding how certain car oils are affected by weather, thereby affecting their density, is necessary to keep one's car running adequately without leaving harmful residue behind in the mechanics. For this experiment, I will be testing the density of three different kinds of oil: olive oil, mineral oil, and Wilbert's lemon oil. I will test the oils' density before and after being placed in the freezer to see if there is a noticeable difference in the density of the oil. I predict that all of the oils featured in this experiment will be more dense after sitting in the freezer for an hour. I came up with this hypothesis after reviewing other density related science experiments. What further assisted in the making of this hypothesis was the recalling of the fact that objects with lower temperatures (such as air or water) become denser. Two experiments that I found to be quite similar to this one were the Density Column and the Bubbling Lava Lamp. The Density Column measures the density of seven different liquids by layering them on top of each other. By doing this experiment, one is able to find out which liquid is the most dense; with the order ascending from there. Based on the results, they found that not all oils are the same density. Vegetable oil came in fifth from the bottom of the tower; lamp oil was the seventh and last layer in the column (Spangler, 2012). In the Bubbling Lava Lamp experiment, the fact that water is denser than vegetable oil was taken advantage of. Using an Alka-Seltzer tablet, the formed carbon monoxide bubbles that pushed the water up and through the vegetable oil. What happened thereafter is that the Alka-Seltzer bubbles would pop and the colored water would sink back down to the bottom of the container through the oil (Spangler). Regardless of penetration, the two liquids did not mix. While temperature was not a key factor in either experiment, they did show that the liquids differing in densities would not mix despite what was happening to them or around them — and that is important for this experiment. In order for Bubbles Up to work properly, the oils cannot mix with the water they are floating on top of no matter what happens. To conduct the science experiment, I used the following items: (3) 12 ounce cups (1) marble (1) dime (1) penny a pitcher of water a bottle of olive oil a bottle of mineral oil a bottle of Wilbert's lemon oil blue food coloring a freezer a timer a measuring cup a spoon or a pair of tongs to retrieve the objects from inside the cups soap and water solution to clean the objects off paper towel thermometer : In the experiment Bubbles Up, the observer will drop various objects into each of the three cups and record how many bubbles of oil they observe. While the results may vary slightly from mine, it may be because of ambient temperature of the room they are working in. This design plan was chosen because timing how fast an object fell to the bottom of the cup is impossible without computer assistance. However, counting how many bubbles of oil occur within the water is a good measure of how dense the oil is because of it being light enough to fall with the object. The reasoning behind this experimental design in terms of whether or not the density of oil changes with a change in temperature was a matter of working with limited resources. I have not found any other experiment using this method to test density; but there is a similar experiment for testing viscosity. In The Viscosity of Motor Oil, a marble was dropped through a a graduated cylinder of motor oil three different times. Each time, the motor oil was a different temperature. Density, volume, and velocity were used as variables to solve for viscosity (Ani, 2011). To begin, set up your work station. Mix the food coloring with the mineral oil. Fill each cup with four ounces of water. Then, fill one cup with six ounces of olive oil. Wash out the measuring cup; then fill a different cup of water with six ounces of mineral oil. Wash out the measuring cup again. Fill the last cup of water with six ounces of Wilbert's lemon oil. At this point, you should have three cups — all of which have a different color oil floating on water. Set up the rest of your materials so that are out of the way, but within easy reach. Set up your data table (see table below). Proceed to Experiment 1. Part 1 Step 1 — Pick up a marble and drop it from the rim of the olive oil cup. Record how many bubbles of oil float upwards from the bottom. Carefully remove the marble with a spoon or tongs and wash it off with soap and water. Repeat this step with the dime and penny, making sure to remove each object and washing it off before moving on to the next object. Step 2 — Repeat step one exactly for the mineral oil cup and lemon oil cup.

Step 3 — After ensuring you have recorded all data and washed all objects clean, proceed to Experiment 2. Part 2 Step 1 — Place all three cups containing oil in the freezer. Set the timer for one hour. Step 2 — After one hour has passed, carefully remove the cups from the freezer, one by one, making sure to not shake them. Step 3 — Repeat Part 1. Do not skip any steps. Step 4 — After ensuring that you have recorded all data, carefully clean up. Have an adult assist in the disposal of the oil — water mixtures if you are under 18 years of age. You will observe how many bubbles float up through the water after dropping an object in, one at a time. Do this with one object, one cup at a time to retrieve accurate results. Remove the previous object before dropping the next one in (ie.; drop in the marble, record the data, remove the marble, drop in the dime, record the data, remove the dime, drop in the penny, record the data, remove the penny, go to the next cup and repeat). The data table should be set up in this manner: [Image Not Included] : I first recorded my data on paper with a pencil, then re-typed it on the computer. I suggest doing this so that there isn't a possibility of damaging your electronic devices. The independent variables of this experiment are the oils. They will be tested in two differing temperature conditions. The dependent variables are the number of bubbles observed after dropping the objects into the cups. The number of bubbles should differ based on being a difference in the density of the oils after their temperature decrease. The control variables are the objects being dropped into the cups. They are constant and do not change in composition in any manner. While there are ways to ruin the validity of this experiment, I have taken steps to reduce and/ or completely cancel out threats to validity. The objects are all dropped from the rim of the cup to ensure that there are no variations in height from which they are dropped. Should there be a variation in height, that could very well affect the number of bubbles produced. All of the cups have four ounces of water in them so that there is the same amount of space for the bubbles to be observed within in each cup. All objects are washed off before being used again to avoid the oils mixing together. All objects are reused for each cup so that there isn't a variation in weight of the marble, dime, and penny. A variation in weight could affect the number of bubbles produced. When the cups were placed in the freezer, they are all placed on the same shelf in a row going side to side. By doing this, I have reduced the chances of any cup being in a section of the freezer that was cooler or warmer than another section. Lastly, I have made it a point to record the data immediately after observation so the chances of forgetting are practically impossible. With those steps taken, the validity of Bubbles Up has been ensured. I began the experiment by mixing the food coloring and mineral oil together. I then filled each cup with four ounces of water.. Then, I filled one cup with six ounces of olive oil; washed out the measuring cup and repeated this action with the mineral oil and Wilbert's lemon oil. I carefully laid out the rest of my materials so that they were within easy reach, but out of the way of my work space. Lastly, I set up the data table so that I could easily write down my observations. I began by picking up the marble and holding it to the rim of the cup of olive oil. I proceeded to drop it in and counted the number of bubbles of oil that appeared. I then wrote down the number in the date table. I then carefully removed the marble with a spoon and washed the two items off. I then picked up the penny and held it to the rim of the same cup and dropped it in. I counted the number of bubbles and wrote down the data into the table. I then removed the penny with the spoon and washed both off. Lastly, I picked up the dime and and held it to the rim of the olive oil cup before carefully dropping it into the cup. I then counted how many bubbles came up and wrote the number down. After removing the dime with the spoon, I washed the dime and spoon off. I then moved on to the cup of mineral oil. Starting with the marble first again, I held it to the rim of the cup and dropped it in to the cup. After counting how many bubbles appeared, I wrote the number down. I then removed the marble with the spoon and washed them off. Then, I moved on to the penny and held it to the rim of the cup and dropped it in. I wrote down the number of bubbles I observed after dropping the penny in. The penny was then removed with a spoon and both were washed off. Last came the dime to be dropped in from the rim of the cup. Post-observation of the bubbles, I wrote the number I had seen. Before going on to the last cup, I removed the dime from the cup with the spoon and washed them off. Turning my attention to the cup of Wilbert's lemon oil, I picked up the marble and dropped it in from the rim of the cup. Counting the number of bubbles, I wrote how many I observed. Carefully, I removed the marble from the cup with the spoon and washed the two items off. Then the penny was dropped in from the rim and the number of bubbles was counted. The data was collected and written down into the table. The penny was removed with the spoon and the two items were washed off. Lastly, the dime was dropped into the cup from the rim and the number of bubbles that appeared was counted; that number was then written down into the table. Before concluding this half of the experiment, the dime was removed with the spoon and the two were washed off. At this point, the three cups were carefully transported to the freezer one by one. They were each placed on the second to top shelf about halfway from the back of the freezer. The three of the cups covered the length of the freezer from one side to the other (this was done in a two door refrigerator where the freezer and refrigerator stand next to each other instead of one top of the other). I then set the timer for one hour; and after that hour I removed the cups from the freezer and took their temperatures. They were all the same temperature — 43° F. I then placed the cups down on the table in the order they'd been in before (from left to right): olive oil, mineral oil, Wilbert's lemon oil. I restarted the experiment by picking up the marble and holding it to the rim of the cup of olive oil. I proceeded to drop it in and counted the number of bubbles of oil that appeared. I then wrote down the number in the date table. I then carefully removed the marble with a spoon and washed the two items off. I then picked up the penny and held it to the rim of the same cup and dropped it in. I counted the number of bubbles and wrote down the data into the table. I then removed the penny with the spoon and washed both off. Lastly, I picked up the dime and and held it to the rim of the olive oil cup before carefully dropping it into the cup. I then counted how many bubbles came up and wrote the number down. After removing the dime with the spoon, I washed the dime and spoon off. I then moved on to the cup of mineral oil. Starting with the marble first again, I held it to the rim of the cup and dropped it in to the cup. After counting how many bubbles appeared, I wrote the number down. I then removed the marble with the spoon and washed them off. Then, I moved on to the penny and held it to the rim of the cup and dropped it in. I wrote down the number of bubbles I observed after dropping the penny in. The penny was then removed with a spoon and both were washed off. Last came the dime to be dropped in from the rim of the cup. Post-observation of the bubbles, I wrote the number I had seen. Before going on to the last cup, I removed the dime from the cup with the spoon and washed them off. Turning my attention to the cup of Wilbert's lemon oil, I picked up the marble and dropped it in from the rim of the cup. Counting the number of bubbles, I wrote how many I observed. Carefully, I removed the marble from the cup with the spoon and washed the two items off. Then the penny was dropped in from the rim and the number of bubbles was counted. The data was collected and written down into the table. The penny was removed with the spoon and the two items were washed off. Lastly, the dime was dropped into the cup from the rim and the number of bubbles that appeared was counted; that number was then written down into the table. I then removed the dime and washed it and the spoon off. I then disposed of the oils by dumping them out into my back yard; except the lemon oil. I flushed that down the toilet. After cleaning up my work space, I immediately set to digitizing my data table. Please refer to the attached charts for the data table and graphs. The method used to to run this experiment was counting bubbles instead of timing how fast the objects fell through the oil. The reason I did not time the objects' fall was because it was far less than a second for each of them. However, the bubbles were a visible observation and did prove to change with the change of the oils' temperature and density. Because the oil was denser, it stuck more to each object as they fell through and thus produced more oil bubbles in the water. Therefore, the question as to whether or not oil became denser when cooled was answered quite fully. Before freezing the oil, the number of bubbles per oil per object were pretty close in range considering the marble was the heaviest object and the dime was the lightest. It was also taken into consideration that unlike the marble, the two coins could produce only slightly more oil bubbles by flipping as they fell through the oil and water. Throughout the experiment, the coins didn't flip more than one full rotation at any given time. The number of bubbles for the olive oil in order from heaviest to lightest object was 6, 7, and 4; giving an average of 5. 6 bubbles. The number of bubbles for the mineral oil was 6, 5, and 3; providing an average of 4. 3 bubbles. The number of bubbles for the Wilbert's lemon oil was 10, 10, and 9; with a mean of 9. 6 bubbles. If you refer to the chart, you'll see that I didn't add the averages to the chart or graph. My reason in mentioning them is to show that they fell within the range of numbers. However, if you look at the graph, you will see that after placing the oil in the freezer for one hour, the number of bubbles increased across the board. The post-cooling numbers for the olive oil are 11, 10, and 8; with an average of 9. 6 bubbles. The post-cooling numbers for the mineral oil are 9, 7, and 5; with a mean of 7. The Wilbert's lemon oil post-cooling bubble count is 13, 12, and 12; providing an average of 12. 3 bubbles. The conclusion of Bubbles Up is that oil's density is affected by temperature. This conclusion was reached by observing the change in the number of bubbles between the oil being room temperature and chilled in the freezer. Based on these findings, I accept my initial hypothesis of oil's density will increase as its temperature decreases. As seen by the data chart and graph, more oil bubbles were created by the falling objects after the oil had been placed in the freezer for one hour. This conclusion was reached by having a clear and repeatable experimental design. Having a concise experimental design is important because it will help to ensure that there is little room for error. Also, designing an experiment around a scientific inquiry will make it more likely for that specific question to be answered in an accurate and testable manner. If the experimental design is badly planned out, one can have inaccurate results, inaccurate information, and even have an irreparable or injurious mistake occur. The reason for having a well made experimental design is to negate any ill effects that could arise during testing; as well as ensuring valid results. One major factor of a well thought out experimental design is whether or not it can be replicated. Scientific replication in terms of experiments is important because it allows others to see first-hand what the original person observed. It also tests and retests the hypothesis and findings of the original experiment. If the experiment cannot be replicated, there isn't a way to confirm whether the hypothesis is absolutely true and that those results from the first experiment are correct. For example, my experimental design detailed each step of the experiment as well as the conditions under which the experiment was done so that another person could repeat every portion of it down to the temperature of the room I was in. By making my design fairly simple, the steps of the design are easy and clear to follow. I indicated which order I tested things in, I made it clear to wash the items in between cups, I noted how long to leave the oils in the freezer for — among other things. Mentioning every detail — big and small — allows my experimental design to be replicated. Due to having a simple design that is replicable and reliable for its purpose, my study is fairly valid. It covered the purpose of the experiment, answered the question, and tested my hypothesis. I do believe that if this experiment was replicated, the results would be extremely similar. With similar results between the original experiment and a replication, the experimental design would be proven to be valid. The ability to replicate an experiment and achieve similar results is important. If one replicates an experiment exactly and the results are vastly different, then the validity of the experiment does not exist. The experiment would be considered invalid. The reason for this is because a replication of an experiment tests how well the experiment was designed. If the experiment is designed poorly, then the experiment's results may be terribly inaccurate. If the results are inaccurate, then the experiment has proven nothing. The results would be useless and provide no kind of scientific advancement. More importantly, the lack of similar results in experiment replication means that the hypothesis can not be tested to prove it to be right or wrong repeatedly. Therefore, the study would be unproductive and invalid for all scientific purposes. References Spangler, S. 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