Analysis of a volatile liquid essay sample

Environment, Water

The purpose of this experiment was to use various methods of analysis to determine the identity of an unknown volatile liquid. In the first part of the experiment, the molecular mass was found by using water to find the volume of a flask through calculations and this as well as the mass of the gas of the unknown liquid were put into the a manipulated version of the ideal gas equation to determine the molar mass of the liquid, which was 14. 21g per mole. The next part was used to determine the density of the volatile liquid. First the volatile liquid was placed in a pyncometer and massed; water was then placed in the same (now clean and empty) pyncometer and massed. The density equation was manipulated using the data for water to solve for the mL of the capillary tube. This new information was used to find the density of the liquid, which was 1. 33g/mL. The last part of the experiment was used to determine the boiling point of the volatile liquid. A test tube was placed inverted in a flask filled with the unknown liquid that was in a water bath heating.

When bubbles from the test tube slowed and began to go back into the test tube, the temperature was taken and this served as a measurement of the boiling point. The average measured boiling point was 60. 2°C. The measured data was inadequate to identify the liquid with. The unknown liquid was revealed to be methanol; the revealed identity could then be used to compare the data to the actual information for methanol. The molar mass was found to have a percent error of 55. 6%, the density had a percent error of 68. 1% and the boiling point had one of 6. 95%. The measured data for the boiling point was fairly accurate, but the molar mass and the density

both had very large percent error. The reasons for this will be discussed more in the discussion.

Boiling Point

Average Boiling Point: (63. 2+59. 3+58. 1)/3= 60. 2° C

The average boiling point was found by adding each boiling point measured in each of the three trials and dividing this value by three.

Percent Error: {(64. 7-60. 2)/64. 7} x100= 6. 95%

The percent error was found by subtracting the actual value from the theoretical and then dividing this value by the theoretical. This value is then multiplied by 100 to find a percent.

Molar Mass

Volume of the flask: 32. 18g/0. 9975g/mL= 32. 26mL

32. 26mL/1000= 0. 03226

The density of water at room temperature was found to be . 9975g/mL. The density equation was manipulated so that the volume of the container could be found by dividing the grams of water in the flask by the density of water. This was then converted to liters by dividing the amount of mL by 100 because there are 1000 mL in a liter.

Mass of gas: 29. 129-29. 111=. 018g

To find the mass of the gas, the mass of the flask was subtracted from the mass of the flask with gas in it.

Molar mass of the volatile liquid: {. 018g x 0. 0821 x 298K}/(. 960atm x . 03226L)= 14. 21g To find the molar mass the ideal gas equation is manipulated to find the molar mass. The equation was MM= gRT/PV. The grams of the gas was multiplied by the R constant and the temperature of the room. Then, this value was divided by the pressure of the room multiplied by the volume of the container.

Percent Error: {(32. 04-14. 21)/32. 04}x100= 55. 6%

The percent error was found by subtracting the actual value from the theoretical and then dividing this value by the theoretical. This value is then multiplied by 100 to find a percent.

Density

Volume of Pyncometer: . 015g/. 9975g/mL=. 015mL

The density of water at room temperature was found to be . 9975g/mL. The density equation was manipulated so that the volume of the pyncometer could be found by dividing the grams of water in the pyncometer by the density of water.

Density of Volatile Liquid: . 0209g/. 015mL= 1. 33g/mL

To find the density the mass of a substance is divided by the volume so the grams of the liquid were divided by the mL of the container.

Percent Error: {(|. 791-1. 33|)/. 791} x100= 68. 1%

To find the percent error the actual result is subtracted from the theoretical and the absolute value is taken for this value. This value is then divided by the theoretical and multiplied by 100 to find a percent.

Calculation Summary Data Table

Calculation| Found Value|

Average Boiling Point| 60. 2°C|

Percent error of boiling point| 6. 95%|

Volume of flask| 0. 03226L|

Molar mass of the volatile liquid| 14. 21g|

Percent error of Molar mass| 55. 6%|

Volume of Pyncometer | . 015mL|

Density of Volatile Liquid| 1. 33g/mL|

Percent Error of Density| 68. 1%|

Discussion:

The purpose of this experiment was to analyze an unknown volatile liquid with various methods in order to identify the liquid. This experiment can also be used to determine which methods of identification were the most accurate in identifying the unknown liquid after the identity was revealed. The unknown volatile liquid was methanol. The first part of the experiment was to assess the molar mass of the volatile liquid. A flask was given a cover of aluminum foil and there was a pinhole put in the top. Some of the liquid was added and then evaporated by heating it in a water bath and the flask was massed following each subsequent adding and evaporating of liquid. The mass of the gas was found this way (the mass of the flask with gas in it was subtracted by the original mass of the flask); it was found to be . 018g. The volume of the flask was found by filling the flask with water and using its available data about density and its mass to find the volume through a

manipulated density equation. The molar mass was found by plugging in this information as well as the temperature and pressure of the room and the constant R into a manipulated ideal gas equation.

The molar mass can be found this way because of the ideal gas theory. If any gas is not placed under extreme temperature or pressure conditions, it should in theory behave ideally and the equation can work. Since the liquid, and later gas, used in the experiment was under close to ideal pressure conditions and normal temperature conditions, the ideal gas equation should be fairly accurate. The molar mass that was found was 14. 21g. However, the actual molar mass of methanol is 32. 04. This means that there is a 55. 6% percent error. The molar mass that was calculated was much lower than the actual, which accounts for the very large percent error. An error that could have caused this is that some of the gas may have escaped form the pinhole in the aluminum foil, as the hole was larger than what would be the size of a pin. This would cause the grams of the gas to be less and this also lowers the molar mass quite a bit, which accounts for the very large percent error. The molar mass of a substance is a good way to identify a substance because it is unique to the composition of a substance. However, the molar mass did not serve as a good way to identify the methanol in this experiment because of the large percent error. The next part of the experiment was to calculate the density of the unknown volatile liquid.

The liquid was placed in a pyncometer and massed and then after the pyncometer was emptied water was placed in the same pyncometer and massed. Also the mass of the empty pyncometer was taken. From this

information the density can be found because the density and mass of the water can be used to find the volume of pyncometer. From the volume and the mass of the unknown liquid the density can be calculated and it was found to be 1. 33g/mL. Density is a good way to identify a substance because density is fairly unique. Not many substances, if any, will have the same exact density. This is because density is the mass of the substance divided by the volume and little to no substances share the exact same criteria to have the same density. The actual density of methanol is . 791g/mL. The percent error of the density is 68. 1%. Because this percent error is so large there must be a very large error in the experiment. A possible error could be that there may have been excess of the methanol in the pyncometer before the water was placed in it. This would alter the calculated volume of the pyncometer to be less than it actually was. With the volume being less, this would make the density be much larger than it should be, which accounts for the very large percent error.

The final part of the lab was to measure the boiling point of the unknown liquid. A beaker of the liquid was placed in a water bath and heated with an inverted test tube placed in the liquid. After heating, a stream of air bubbles would come from the inverted test tube. At some point, the bubble were no longer air, but were actually methanol vapor. Once there was a steady stream of bubbles, the beaker with the liquid was removed from the water bath and as the bubbles stopped. This is when the temperature was taken. This is because as the bubbles were moving, the vapor had greater pressure than the atmosphere, but when they stopped before moving back into the test tube, the atmospheric pressure was equal to the vapor pressure.

The boiling point of a substance is when the vapor pressure equals the atmospheric pressure, so this is why it was taken at that moment. The boiling point of a substance is very unique for these reasons. The average boiling point that was measured was 60. 2° C. The actual boiling point of methanol is 64. 7°C. This means that the percent error of the boiling point was 6. 95%. The error is not that great, but an error that could have accounted for a lower measured boiling point is that the thermometer used takes a long time to show the correct temperature. There is a lag time where the thermometer does not show the correct reading. This would cause the measured boiling point to be lower than the actual and this accounts for the error. Post Lab Questions

1. The molar mass that was found was 14. 21g. However, the actual molar mass of methanol is 32. 04. This means that there is a 55. 6% percent error ({(32. 04-14. 21)/32. 04}x100= 55. 6%). The calculated density found to be 1. 33g/mL. The actual density of methanol is . 791g/mL. The percent error of the density is 68. 1% ({(|. 791-1. 33|)/. 791} x100= 68. 1%). The average boiling point that was measured was 60. 2° C. The actual boiling point of methanol is 64. 7°C. This means that the percent error of the boiling point was 6. 95% ({(64. 7-60. 2)/64. 7} x100= 6. 95%). 2. The method that produced data that was closest to the actual data for methanol was the test for boiling point, which only yielded a percent error of 6. 95%. This error is not large, but it still could not conclusively lead to the identification of the liquid. There are many other substances with boiling points close to 60°C. When the other data is included and used to identify the liquid, it is impossible to conclusively identify the substance as the correct liquid

methanol because the data strays so much from the actual data. 3. The fundamental idea of the Ideal Gas Model relies on the idea that the gas is behaving ideally.

This means that there are no intermolecular forces between the molecules of the gas, the molecules obey Newton's law of motion, the molecules move in all direction with equal probability, and the molecules undergo elastic collisions with the walls. The volatile liquid should have behaved ideally because it was not tested under extreme pressure or temperature conditions, both of which cause gasses to no longer behave as ideal. The fact that it should have behaved as ideal is the very reason that the ideal gas equation could be used. 4. These methods of identifying the molar mass, density, and boiling point could not be used with gallium because it is not a liquid at room temperature and its boiling point is very high. In testing the molar mass and the boiling point, the gallium would have to be heated to very high temperatures (each time for the vaporization of the gallium) and the lab materials would not be able to heat it up to the necessary temperature. This temperature would also have to be sustained for massing, and this would be impossible in the lab conditions. Octane could be tested, but it is not a liquid at room temperature so the increased temperature would have to be sustained for testing.

It is also not as volatile as methanol and would prove difficult to identify because it has many different isomers, each with a distinct molar mass and density. Butane could in theory be tested, but it is much more volatile than methanol and would even have to be cooled to behave as a liquid. Because

of this, it is very difficult to test the boiling point in the method that was used for the lab. The water bath that the methanol was heated in, would not have to be heated and the lab could not be performed at room temperature, it would need to be done at around 1°C, which is not very plausible for the lab conditions. Out of all of these substances water would be the easiest one to test as it is a liquid at room temperature and it has a fairly low boiling point, as does methanol.

However, much of the data was determined by using water itself to find missing variables and so the water would be compared with itself. This does not limit its ability to be tested in any way, but it does allow for a lot error in comparing the unknown, but secretly water with itself. 5. The measurement errors for the molar mass calculation piece of the lab include an inaccurate measurement of the mass of the gas in the flask and in inaccurate calculation for the volume of the flask. For the mass of the gas, some escaped through the pinhole in the top of the flask and this greatly lowered the molar mass. The volume of the flask should have been greater, which actually made the molar mass slightly more than it should have been. These errors did not cancel each other out as the molar mass was still much lower than it should have been. This means that the mass of the gas affected the data much more than the inaccurate volume did.

Sources:

http://www. sigmaaldrich. com/chemistry/solvents/methanol-center. html
http://misterguch. brinkster. net/molarmass. html

http://www. phys. hawaii. edu/~teb/java/ntnujava/idealGas/idealGas. html

http://www. chemicool. com/elements/gallium. html