Title: Fractional Distillation

Purpose: To observe what happens when a liquid-liquid mixture is heated and allowed to boil over a period of time and distillate them by measuring the density of each fraction.

"Before Lab" questions and information:

1. Water = 100ºC

   Ethanol = 78.4ºC

2. See Attached Sheet

Procedure: 60 mL of ethanol and 60 mL of water were combined in a 250 mL round bottom flask along with 3-4 boiling chips. A distillation apparatus was assembled to create, trap, and measure the temperature of the vapor. The solution was heated at a moderate rate. The temperature at which vapor first reached the beakers at the end of the tube was recorded as the initial temperature of vaporization. Three 10 mL volumetric flask were weighed with stopper. The flasks were cleansed with 1-2 mL of the distillate. After 30 mL of distillate had been obtained, the volumetric flasks were filled with 10 mL after removing the cleanser. The 10 mL samples were then weighed as well for two other cycles as well.

1.

Table 1

Average Mass, Mass of Distillate, and Average Density for Distillate Trials 1-3

	Flask 1	Flask 2	Flask 3
Average Mass (g)	12.662	13.018	13.237
Mass of Distillate (g)	8.120	8.930	9.430
Average Density (g/mL)	.8120	.8930	.9430

2.

Table 2			
Percent Ethanol in Distillate Trials 1-3			
	Flask 1	Flask 2	Flask 3
Percent Ethanol	91.34	58.98	33.97

3. The primary component is ethanol. The solution would not be pure because there is inevitably some water escaping due to evaporation and vaporization along with the ethanol even though the content is primarily ethanol.

4. The initial boiling point of ethanol was found to have been 76 degrees Celsius. This boiling point is lower than both ethanol (78.4 degrees Celsius) and water (100 degrees Celsius.)

5. The temperature of the vapor was observed to have a higher temperature as the experiment continued. This observation is correlated to the composition as water requires more energy to vaporize water and the later vapor contained more water than the earlier vapor. Thus, there is more energy contained in the water vapor as heat.

6. a. See Attached Sheet.

b. The calculated values are lower than the densities published value. Even if the mixture is 50% water and 50% ethanol, there is not an exact mixture so when the densities are measured, the experimental values are not as exact. Volume is very difficult to measure and thus, the volumes measured for the experimental data were too low. It is much easier to measure out equal portions of mass than it is equal portions of volume.

Error Analysis: Judging by the temperature that was read at the initial vaporization, it is obvious that there was error in this experiment. The temperature at which the initial vaporization occurred was lower than both that of ethanol and water, when it should lie somewhere between, but closer to ethanol. This must have meant there was either a leak around the thermometer which allowed cooler air to affect the thermometer or hotter gas may have escaped without being measured. By calculating the percent ethanol by the equation of the line, error is also added because the line is not exact. While the error is small, the line is not a perfect fit.

Conclusion: Through distillation and density analysis, it was found that the substance of a lower boiling point vaporizes before one of a higher boiling point, but not purely so. Although not initially, the boiling point of the ethanol and water solution was found to have been between both of the known vaporization points.