

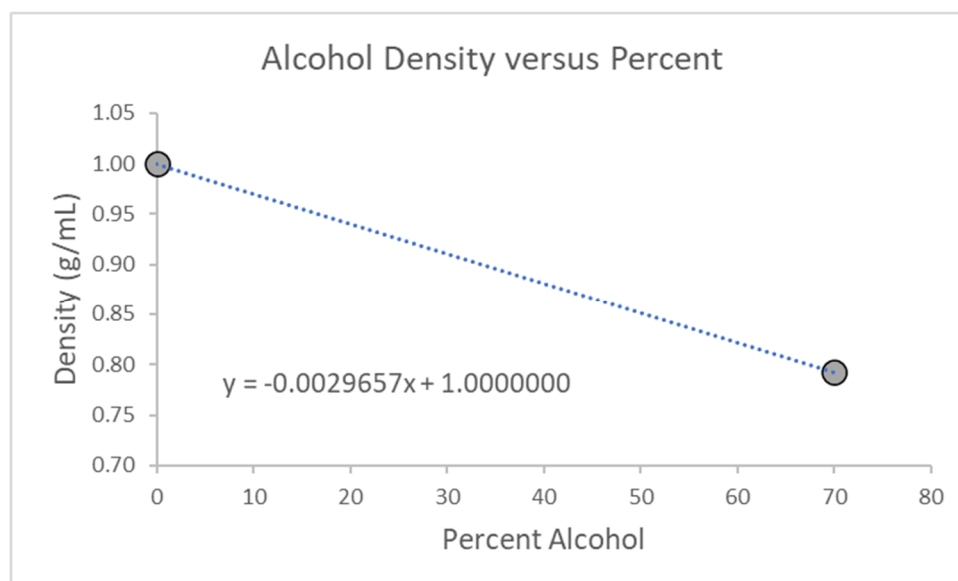
CHEM 101 Online Experiment:**Alcohol Density****Introduction**

A traditional way of determining the concentration of alcohol in alcoholic beverages is by measuring the density of the solution, since these two characteristics of the solution (density and percent alcohol) are related. This is a convenient determination method because it is low cost and can be done quickly. Customs officials sometimes use density measurements to classify alcoholic beverages and spirits. Canadian importation laws use these five categories of alcohol strength:¹

category	percent alcohol (v/v) *	examples
1	< 0.5	
2	0.5 – 1.2	
3	1.2 – 7.0	<i>beers and coolers</i>
4	7.0 – 22.9	<i>strong beers, wines, fortified wines</i>
5	> 22.9	<i>liqueurs and spirits</i>

* v/v means “volume per volume”

In this online experiment, you will first of all measure the densities of two standards: distilled water and 70% pure ethanol. These two densities will be used to prepare a graph of density versus percent alcohol, with water representing the minimum possible 0% alcohol. A sample graph is shown below, along with the trendline and equation of the line.



The densities of two alcoholic beverages will also be measured. The equation of the line for the two standards will be used to calculate the percent alcohol of the two beverages. Each beverage is then classified into the appropriate category in the above table.

Experimental Procedure

This is detailed on the website and basically requires:

1. Accessing the Virtual Lab website.
2. Watching the 6-minute video demonstrating the VL software for this experiment.
3. Performing the VL experiment to obtain the masses of 10 mL samples of the four liquids:
 - Distilled water
 - Alcoholic Beverage A
 - Alcohol 70%
 - Alcoholic Beverage B
4. Using either MS-Excel or Google Sheets to prepare and print a graph of Density versus Percent Alcohol, which contains only data-points for water and 70% alcohol.
5. Using formulas within either MS-Excel or Google Sheets to calculate the percent alcohol for the two beverages.

Video guidance (11 - 12 minutes long) is provided for graphing and creating an equation. You may choose from either the MS-Excel or Google Sheets presentations.

CALCULATIONS

As noted in the Physical Properties experiment, density is defined as the mass per unit volume of a substance:

$$\text{density} = \text{mass} / \text{volume}$$

As noted in the graphing videos, the equation for the line-of-best-fit ($y=mx +b$) will be used, where y = alcohol density and x = percent alcohol. The intercept value (b) is expected to be 1.00 and the slope (m) will be based on the graph that you produce. **Ensure you obtain a slope value to at least 4 significant figures.** Re-arrange to:

$$x = \frac{(y - b)}{m}$$

Solve for “ x ” (percent alcohol of the two beverages) by simply plugging in the appropriate y -value (density) for each beverage. Answers should lie in the range of 1 – 60 %.

Give your final answer on the report sheet with the correct number of significant figures.

ⁱ Introduction paragraph copied from Virtual Lab module written by Mr. Tim Palucka and Dr. Jordi Cuadros, Instituto Químico de Sarriá, 2018. All else written by Dr. Matt Le Page 2020.