# Report: Signature Assignment: Expansion of Fluids

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This is your lab report for the Signature Assignment: Expansion of Fluids lab. Fill out the report as you work through the experiment. You can fill in the report in whatever way works best for you: print the report and fill it out with pencil, fill it out digitally with a tablet pencil, or fill it out by typing in Microsoft Word or another word processing program.

As part of a campus-wide initiative, all courses with a General Education (GE) designation are incorporating a Signature Assignment that addresses a Big Question. The definition of Signature Assignment is as follows:

*A Signature Assignment (SA) requires that students integrate and apply course content to address a significant personal, social, or professional question or issue in some way (e.g., through critical thinking, creative thinking, problem-solving, quantitative literacy, inquiry and analysis, etc.) for a specified audience.*

You will complete the following lab the same way you have completed the rest of the labs this semester; the audience you will be addressing is your scientific peers and your instructor.

When you are ready to hand in the report, save your document as a PDF (if you are printing the document, you will need to scan it: Adobe Scan is free for smartphones if you do not have a scanner). Upload your completed document to the Canvas Assignment for this lab. Lab reports are due on Sundays at 11:59pm.

## Part 2: Analysis

marble

Question 1: In the spaces below, show your work for the calculation of the volume of the spherical marble. The diameter is given in the Expansion of Fluids Data Excel document – keep in mind when calculating the volume that you were given the *diameter*, not the radius.

$V = \frac{4\pi r^3}{3}$ or $4/3\,\pi r^3$

$d = 2.521$ cm

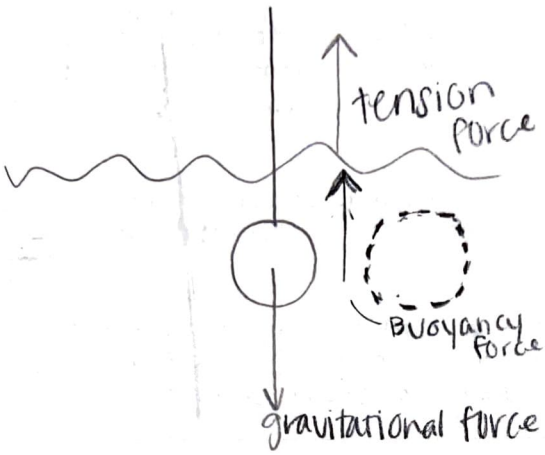
$r = \frac{d}{2} = 1.2605$

$V = 4/3\pi(1.2605)^3 = 8.389$

$8.389\ cm^3$

$\Sigma F = m\cancel{a}^{0} = F_g + F_T = 0$

**Question 2: Draw the free body diagram of the marble suspended in water. You should have three forces – be sure to label them clearly!**




$\Sigma F = m\cancel{a}^{0}$

**Question 3: Using the free body diagram you drew in Question 2, use Newton's Second Law ($\Sigma F = ma$) to derive an equation that has both the density of water ($\rho$) and the apparent mass of the marble ($m_a$). If you need help getting started, take a look at the derivation of the marble in air shown in the video, and repeat the process for the marble in water.**

★

$p \neq ma$ $\quad P = \frac{m}{V}$

$\Sigma F = m\cancel{a}^{0} = -F_g(m_a) + F_T = 0$

$F_b = PVg$

$V = \left(\frac{m}{P_o}\right)$

$M_o - M_a = P_o V$

**Question 4: Given your result derived in Question, do you expect the apparent mass to increase, decrease, or remain constant as temperature increases? Explain your reasoning.**

As temperature increases, I think the apparent mass of the object will increase. molecules are moving faster in warme water ≠ I think this will cause the object to seem more heavy because the molecules aren't holding it up as much.

**Question 5: Solve the expression you derived in Question 3 for the density of water in terms of the apparent mass; that is, solve so that $\rho$ is isolated on one side of the equation.**

$$\rho = \frac{M_o - M_a}{V}$$

**Question 6: Look up the known density of water in whatever units you calculated in Excel. Do the values you determined seem reasonable compared to the known value? Why or why not?**

Known: $1 g/cm^3$ calculated: $\approx 1.01 g/cm^3$

Yes these values seem reasonable they are nearly the exact same.

**Question 7: Describe the overall trend you see on your graph. How does temperature affect the density of water? Is this what you expect? Why does (or doesn't) this make sense?**

Density decreases as temperature increases. So when the water heats up the density decreases. Yes this makes sense. Think iced hot water cold water is closer to ice & likely more dense.

**Question 8: Lake Baikal in Russia is the world's deepest freshwater lake, at 5,387 feet deep. The very bottom of the lake is *always* 4°C. What does this fun fact tell you about at which temperature water is the densest? Does your graph show you the same conclusion?**

Yes this means @ 4°c water is at its most dense. There is a point on my graph that proves the exact point!

$P_1$ $P_2$
$1.0113 - 1.0106$

Question 9: Report below how much the density of water changes between 17°C and 19°C.

Density Change = .0007 g/cm

Question 10: A 2°C change in water temperature may not seem like a huge change, and the change in density may also not seem that large, but on a global scale it is very significant when it comes to rising ocean temperatures. Calculate the change in sea level depth using:

$$\Delta d = \rho_1 d\left(\frac{1}{\rho_2} - \frac{1}{\rho_1}\right)$$

where $\rho_1$ and $\rho_2$ are the initial and final densities, respectively, $d$ is the average depth of the ocean (4.24km), and $\Delta d$ is the change in depth of the ocean.

Using the data you've collected, determine the change in depth of the ocean purely from the expansion of water. Use values of $\rho_1$ and $\rho_2$ that are at 17°C and 19°C from your data table.

$1.0113\frac{g}{cm^3}(4.24\,km)\left(\frac{1}{1.0106\frac{g}{cm^3}} - \frac{1}{1.0113\frac{g}{cm^3}}\right) = 0.00294\,km$

2.94 m

~3 meters from 2 degrees!

Question 11: The math you used above applies to *all* the water in the ocean; in reality, only the top 100 meters of the ocean are affected by changes in temperature. This means only about 2% of the ocean goes through this temperature change. While this may make the value you calculated above seem less of a big deal, can you think of reasons why thermal expansion of the ocean may still be significant?

I can see a huge problem with shore lines & flooding if the depth of the ocean increases to much due to thermal change.

**Question 12: What major factor(s) other than the expansion of water that you explored today affect rising sea levels?**

-melting of ice caps!
-Trash in the ocean (displacement)?

**Question 13: Scientists often study a very small portion of a much larger picture; for example, some scientists were able to make likely implications about climate change by studying the migratory patterns of monarch butterflies. What role does collaboration play in how scientists draw large conclusions on issues that affect the whole world?**

Well, if scientists can make a system that can relate to the world on a larger scale, we can take much smaller experiments & relate them on a global scale. If the butterflies have been migrating sooner due to temperature increases, the scientists could relate that to climate change

**When you're done, save this report as a PDF, and upload it to the Signature Assignment: Expansion of Fluids Report Assignment. Also upload your completed Excel worksheet; it should have all of your tables and graphs from this assignment.**