

SC111 – Extra Excel Assignment¹

After completing the graph for Expt. 5B, do this assignment to learn more about spreadsheets.

1. The density of water from 4° to 40°C can be calculated using the equation:

$$\text{Density (g / mL)} = a_0 + a_1 \cdot T + a_2 \cdot T^2 + a_3 \cdot T^3$$

where T is the temperature in °C, $a_0 = 0.99989 \text{ g/mL}$, $a_1 = 5.3322 \times 10^{-5} \text{ g/mL } ^\circ\text{C}$, $a_2 = -7.5899 \times 10^{-6} \text{ g/mL } ^\circ\text{C}^2$, and $a_3 = 3.6719 \times 10^{-8} \text{ g/mL } ^\circ\text{C}^3$.

2. Use the following template to begin constructing your spreadsheet. Note the alignment of the cells and the number of digits displayed in the numbers.

	A	B	C	D	E
1	Calculating the Density of Water at various Temperatures				
2					
3	Constants:			Temp (°C)	Density (g/mL)
4	$a_0 =$	0.99989		5	
5	$a_1 =$	5.3322E-05			
6	$a_2 =$	-7.5899E-06			
7	$a_3 =$	3.6719E-08			
8					
9					
10					
11					

3. You will now write a formula to calculate the range of temperatures. Place your cursor on cell D5 and type in “=D4 + 5” (begin with the = sign and don’t use the quotes). Press Enter and then Copy cell D5 and Paste it into cells D6 to D11 (use the Edit menu to Copy and Paste). You should see a range of temperatures from 5 to 40°C in Column D. Place your cursor on cell D11. What is the equation in this cell? Do you notice that the equations are automatically incremented?
4. Place your cursor on cell E4 and type in the following equation for calculating the density. Your equation should look like:

$$= \$B\$4 + \$B\$5 * D4 + \$B\$6 * D4^2 + \$B\$7 * D4^3$$

This formula is a translation of the equation in #1. After you press Enter, the number 0.99997 should appear in cell E4.

The \$ symbols in the above formula denote an absolute reference. For example, \$B\$4 is an absolute reference. No matter where cell \$B\$4 is called from in the spreadsheet, the computer goes to cell B4 to look for a number. If a formula containing \$B\$4 is copied to another cell, the address for \$B\$4 is NOT incremented. D4 is a relative reference in the formula above. When the formula is copied to another cell, this reference is incremented appropriately.

5. Copy and Paste the formula in cell E4 to cells E5 to E11, or try the Fill function. With the mouse, highlight cells E4 to E11, then select Edit, Fill, Down. In either case, the formula from E4 should be pasted (and appropriately incremented) into cells E5 to E11. If your formula is correct, you should have the value 0.99223 in cell E11. Place the cursor on cell E11 and note what was incremented in the formula and what remained constant. Do you understand the purpose of a \$ sign in an equation?

¹ from *Quantitative Chemical Analysis*, C.D. Harris, W.H. Freeman & Company, 1999.

6. Now prepare a graph of Density vs. Temperature (y vs. x). Is this relationship linear?
7. One last challenge is to investigate the density properties of D₂O (deuterium oxide or heavy water). Copy and Paste the values in cells B4-B7 to cells C4-C7. Now replace the values in cells B4-B7 with the constants for D₂O:

$$a_0 = 1.10447$$

$$a_1 = 2.35580 \times 10^{-4}$$

$$a_2 = -1.14696 \times 10^{-5}$$

$$a_3 = 6.55034 \times 10^{-8}$$

As you change each number, you should see the values in column E and your graph automatically updated! This is the beauty of using equations and absolute references in a spreadsheet. Repetitive calculations can be done more efficiently.

8. Can you find a way to edit your spreadsheet and graph to show a plot of both the densities of H₂O and D₂O vs. temperature on the same graph? Do you see where the name “heavy water” comes from?