

# The chemistry of natural waters flashcard



**ASSIGN  
BUSTER**

The Chemistry of Natural Waters Introduction: Water will be taken from 4 different taps. The first will be Hamilton hall in the west residence halls. The second from Bigler hall in East residence halls.

The third from University Towers on College Avenue. The fourth will be taken from Heritage Oaks apartment complex near Wal-Mart. My sample will be taken from Hamilton Hall in the west residence halls. I expect the water from the residence halls to be softer than the water taken from the apartments off of the Penn State University Campus. I believe this because the water on PSU campus is controlled by Penn State and I believe that they would expend more resources to make the water on campus softer for the students.

I think the water off campus will be relatively hard because the apartment complexes do not have the resources to soften the water as Penn State University does, and water softening is not a very large concern. I will approach the analysis of these waters in two different ways. I will use Atomic Absorbance to measure the concentration of  $Mg^{2+}$  ions and  $Ca^{2+}$  ions with an atomic absorption spectrophotometer. I will also test the water using EDTA which measures the total solids dissolved in the water.

Procedure: To begin this experiment I took my water sample to the Atomic Absorption Spectrophotometer. This analyzed the light absorption of two ions: calcium and magnesium. To continue this experiment I performed EDTA titration to find the hardness of the water and used this to compare with the Atomic Absorption concentration of magnesium and calcium. To perform the EDTA titration I followed section C and D of my Chemtrek lab manual.

After determining the hardness I softened the water using Calcium carbonate. All of these steps are elaborated upon in the Chemtrek lab manual (1). Results: Graph 1 PlaceAA Ca<sup>2+</sup> concentrationLight absorbance of Ca<sup>2+</sup>AA Mg<sup>2+</sup> concentrationLight Absorbance of Mg<sup>2+</sup> Hamilton Hall(7)31. 17mg/L0. 247021. 50mg/L0.

5255 Bigler Hall(8)47. 06 mg/L0. 373227. 88 mg/L0. 6691 University Towers(9)44. 88mg/L0.

355922. 54mg/L0. 5481 Heritage Oaks(10)23. 25mg/L0. 184116.

99mg/L0. 4276 These values were then compared to the calibration graphs for the Atomic Absorption Spectrophotometer for that day. These graphs are given on the next page. These graphs were used to derive a concentration of each ion given the light absorbance of each ion. The equation for each ion is given below(7): Equation 2 Equation 1 124. 93(.

2470)+. 1633= 31. 02mg/L 62. 094(. 5255)-3. 192= 21.

47mg/L Chart 1 Chart 2 These concentrations of magnesium and calcium ions were then converted to parts per million so that they could be compared adequately. They were converted the following way(7): Equation 3 31.

17mg/L\*1l/1000g of water= 31. 17mg/1000g= 31. 17 parts per million Table 2 PlaceCa<sup>2+</sup> ConcentrationMg<sup>2+</sup> Concentration Hamilton Hall(7)31.

17ppm21. 50ppm Bigler Hall(8)47. 06ppm27. 88 ppm University Towers(9)44. 88ppm22.

54ppm Heritage Oaks(10)23. 25ppm16. 99ppm These numbers were then combined to reach a total hardness of the water. This was reached by using the equation below: Equation 4(3)  $((31.17\text{ppmCa}^{2+})^2 +$

$5\text{ppmCaCO}_3) + ((21.50\text{ppmMg}^{2+})^2 + 4.12\text{ppmCaCO}_3 = 166.5\text{ppm}$  total hardness Table 3 Place Total Hardness Hamilton Hall(7)166. 5ppm Bigler Hall(8)232.

5ppm University Towers(9)205. 1ppm Heritage Oaks(10)128. 1ppm Results for the EDTA titration were as follows Place Total Hardness Hamilton Hall(7)240ppm Bigler Hall(8)480ppm University Towers(9)310ppm Heritage Oaks(10)200ppm These values were reached by serial titration in the case of the Hamilton Hall water reached in this manner(1): Equation 4 Molarity of EDTA \* Volume of EDTA = Molarity of  $\text{Ca}^{2+}$  \* Volume of  $\text{Ca}^{2+}$   $2 \times 10^{-4}\text{M} \times 12 = X = .0024\text{M}$  This was then converted to parts per million using this equation Equation 5(7)  $.0024\text{moles/liter} \times 100\text{gCaCO}_3 / 1\text{moleCaCO}_3 \times 1000\text{mg/g} = 240\text{mg/L}$   $240\text{mg/L} \times 1\text{L} / 1000\text{g} = 240\text{mg} / 1000\text{g} = 240\text{ppm}$  This was then converted into grains per gallon using the next equation(7): Equation 6  $240\text{ppm} \times 1\text{grain per gallon} / 17.$

$1\text{ppm} = 14.035\text{grains/gallon}$  Equation 4 was also used to determine the molarity of the  $\text{Ca}^{2+}$  ions in the water after a softener had been added and also after cat ion exchange resin was added. Discussion: The final values of hardness were quite surprising. My original hypothesis was that the water on campus would be softer than the water off campus because Penn State University has more money to soften their water. I found, however, that this was not true.

The water on campus was not necessarily softer than the water off campus. The water from Hamilton Hall was softer than the water from University towers. The water from Heritage Oaks however was the softest water of all and it was located off campus. This fact makes me think that the two locations use different sources of water (5). This is what would account for the difference in the hardness between Heritage Oaks water and the water from in town. Heritage Oaks is located near Wal-Mart which also makes me think that the water in that area must come from a different source.

I feel the precision and accuracy of my AA values was very good plus or minus one percent because a machine performed the calculations. The EDTA precision and accuracy were very large comparatively because human error accounted for some discrepancy in the performance of the experiment. Also the EDTA test not only reveals the calcium and magnesium ions but also any dissolved metal (6). I estimate the precision to approximately plus or minus eight percent. The relative harnesses are as given (2).

The Hamilton Hall water, Bigler Hall water, and University Towers water were all hard. The Heritage Oaks water was only moderately hard. This hardness of the water shows that the washing machines in the residence halls, especially those in Bigler and Hamilton Hall, have the potential to irritate the skin of those who live in those halls. This is caused by the hard water forming a " soap curd" on the skin which does not allow the skin to return to its normal acidic condition (4).

Conclusion: I found that the location of the water relative to on campus or off campus had little to do with the hardness of the water. The hardness of the

water was dependent on the source from whence the water came. This means that the water which came from Heritage Oaks had a supply of water which was much softer than that of Hamilton Hall, Bigler Hall, and University Towers. References: 1) Chemtrek: Thompson, Steven S. ; Prentice Hall: Engelwood Cliffs, New Jersey, 1990 2) Hardness and water quality [http://water.nr.](http://water.nr.state.ky.us/ww/ramp/rmhard.htm)

[state.ky.us/ww/ramp/rmhard.htm](http://water.nr.state.ky.us/ww/ramp/rmhard.htm) 3) Water Hardness [http://home.](http://home.t-online.de/home/hydrobio.hw/twharte.htm)

[t-online.de/home/hydrobio.hw/twharte.htm](http://home.t-online.de/home/hydrobio.hw/twharte.htm) 4) Hard Water Hardness Calcium Magnesium Water Corrosion Mineral Scale [http://wilkes.](http://wilkes.edu/~eqc/hard1.htm)

[edu/~eqc/hard1.htm](http://wilkes.edu/~eqc/hard1.htm) 5) Fox, Martin; Healthy Water. Healthy Water Research: Portsmouth, NH 6) The beginner FAQ [http://faq.thekrib.com/begin-chem.](http://faq.thekrib.com/begin-chem.html)

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