Columbia University
School of Professional Studies

BRITA®

Water Filtration

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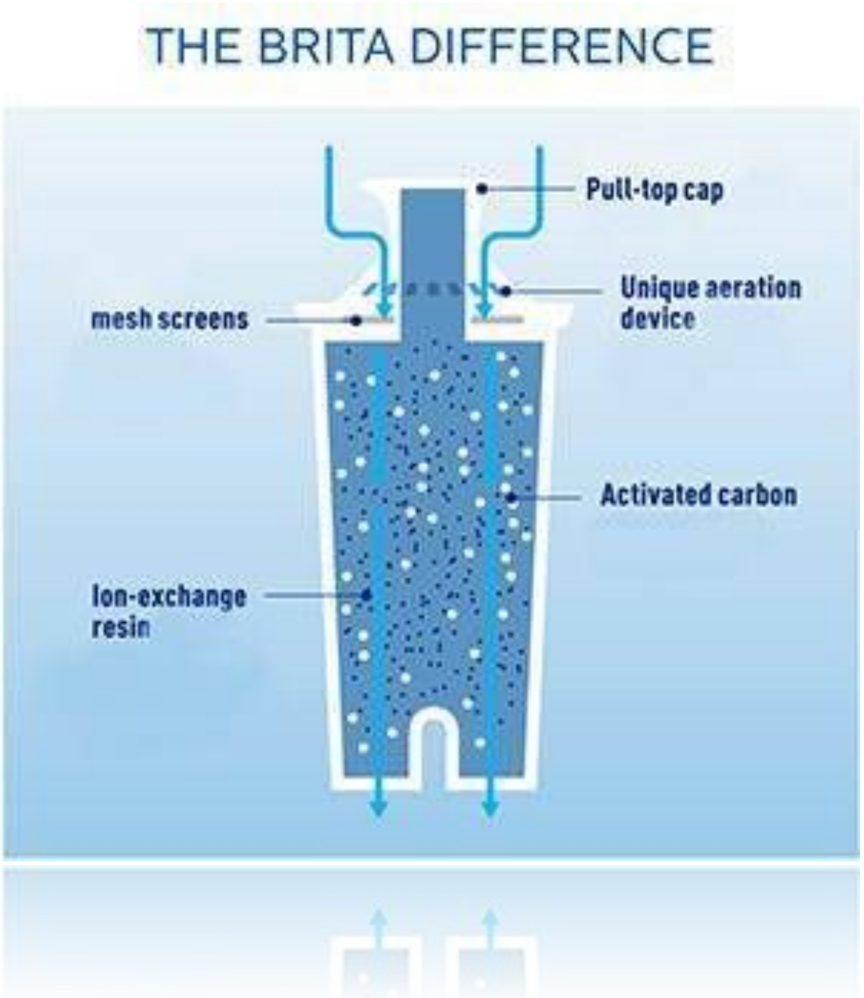
—APPLICATIONS:

- potable water
- biotechnology
(fermentation processing, separation of components from biological fluids)
- industrial processes
(waste stream treatment, recovery of process chemicals)
- medical procedures
- semiconductor fabrication processes
(using ultra purified liquids)
- fluid recirculation
(aircraft and spacecraft)

—WELL KNOWN METHODS OF WATER FILTRATION:

- reverse osmosis
- distillation
- ion-exchange
- chemical adsorption
- coagulation
- filtering
- retention



Uses coconut-based activated carbon and synthesized ion-exchange resins as sorbent

Hatch, Jacob. "The Brita Infinity Smart Water Filter Pitcher Review." *Hydration Anywhere*, 12 Mar. 2017, hydrationanywhere.com/brita-infinity-smart-water-filter-pitcher-review/.

Background Information

Purpose of Brita® Filter:

- adjusts pH, taste, colour, and odour
- removes contaminants from fluids,

  -small particles, suspended solids, allergens, bacteria, microorganisms, intentionally introduced biotoxins, pesticides, toxic metals (lead, arsenic, mercury), chlorine (a water disinfectant), nitrogen (found in fertilizers)

  And more, such as….

Here's What Brita® Reduces or Removes from Tap Water

	Faucet	Standard	Bottle	Dispenser	Stream	Longlast
Chlorine (Taste & Odor)	●	●	●	●	●	●
Copper		●		●		
Cadmium		●		●		●
Mercury		●		●		●
Lead	●					●
Asbestos	●					●
Benzene	●					●
TTHMs	●					
Cryptosporidium / Giardia	●					
Atrazine	●					
Lindane	●					
Trichloroethylene (TCE)	●					
Particulate Class I	●					●
Zinc		●				

https://www.brita.com/water-pitcher-support/

Objective

The goal of this experiment was to determine the effectiveness of a Brita Filter at removing calcium ions from tap water.

Experimental Protocol

- Our method:
  - Collect 10 samples of water filtered by the Brita Filter.
  - Prepare 3 standard calcium solutions at 0.1, 1, and 10 mg/L
  - Calibrate Atomic Absorption Spectrum and then test the samples
- Alternative method:
  - Prepare a calcium carbonate $CaCO_3$ solution to standardize a solution of ethylenediaminetetraacetic acid (EDTA)
  - Collect 3 standards (tap water that has been passed through the filter)
  - Perform titrations with the EDTA solution of known concentration against the calcium standard samples of unknown concentration.

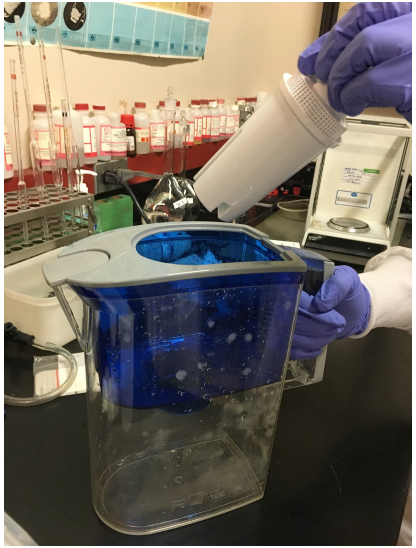
Hypothesis

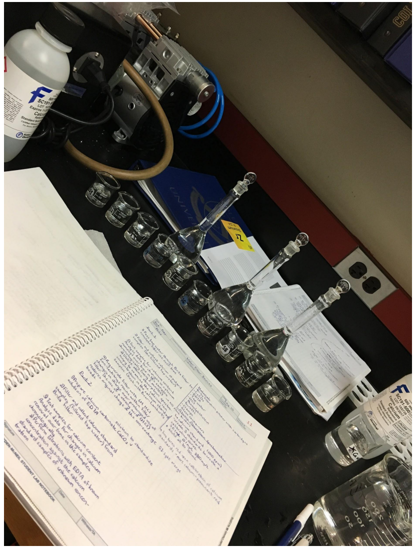
The Brita filter will remove Ca^{2+} ions from tap water less effectively with continual use. Therefore, samples taken towards the end of the experiment will have a higher concentration of Ca^{2+} ions than samples taken at the beginning.

Collecting Samples

Step 1: Simulate Brita filter use by passing tap water through the filter

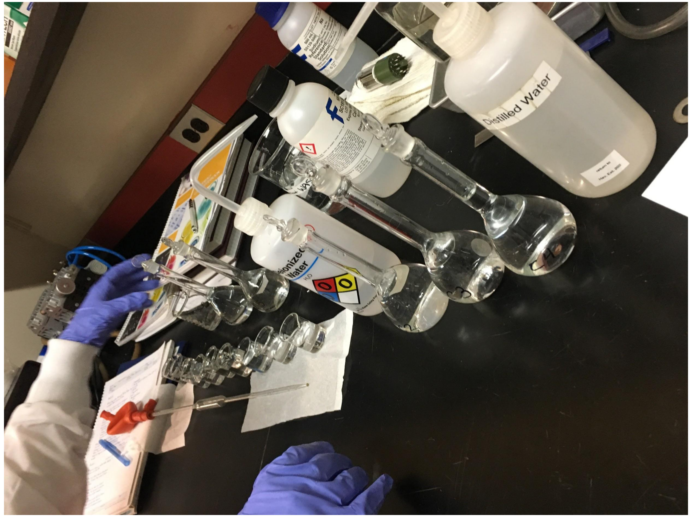
Step 2: Filter and collect calcium samples

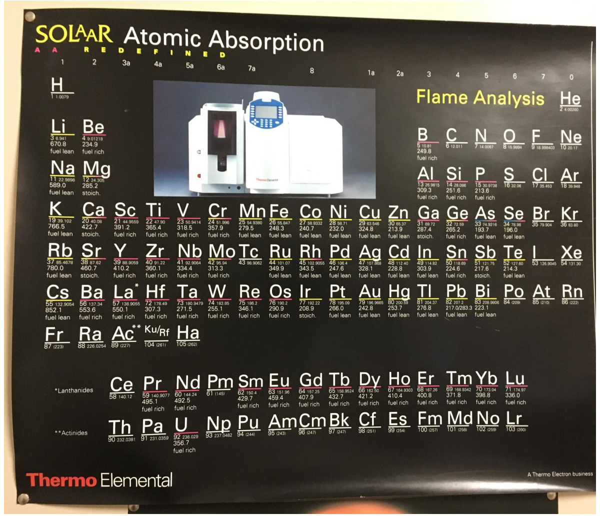




Prepare Atomic Absorption Spectrometer

Step 3: Prepare 3 standard calcium solutions at 0.1, 1, and 10 mg/L

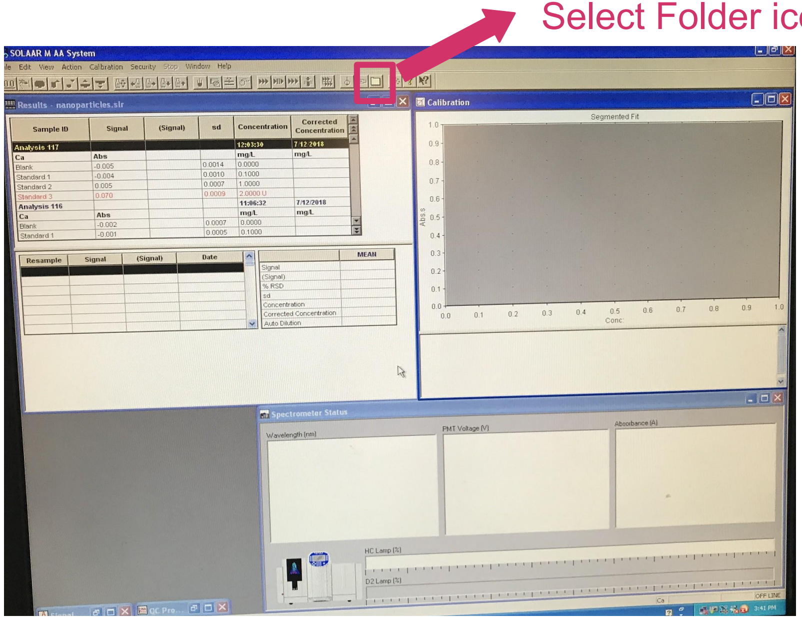




Calibration

Step 4: Calibrate atomic absorption spectrometer

Select Folder icon to open calibration page



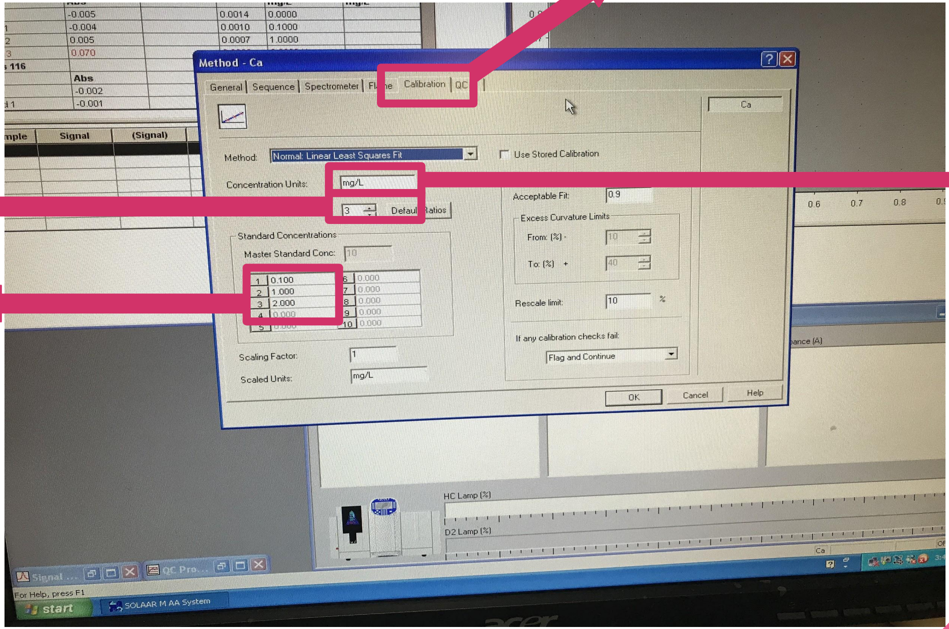
Calibration cont.

1.Select Calibration tab

2. Change units

3. Select number of standards

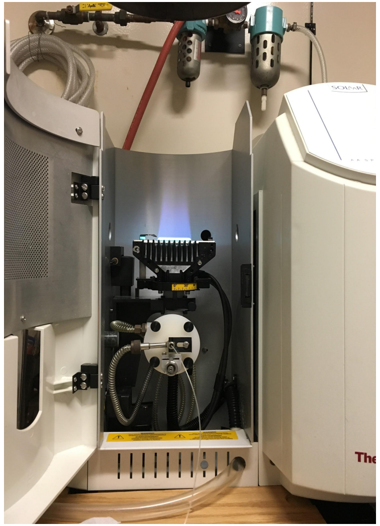
4. Enter concentrations of each standard



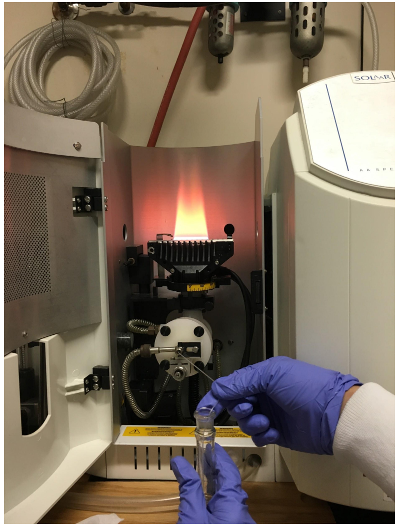
Data Gathering

Step 5: Analyze calcium samples using atomic absorption spectrometry

Before experiment started



After flame was adjusted

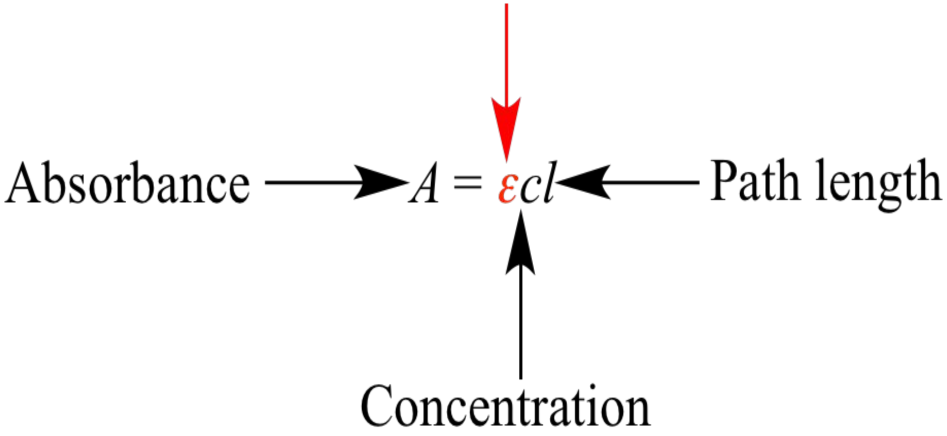


With calcium standard

Double-Checking Data

Step 6: Check using Beer-Lambert's Law

Molar Extinction Coefficient



Calculations using Beer-Lambert's Law

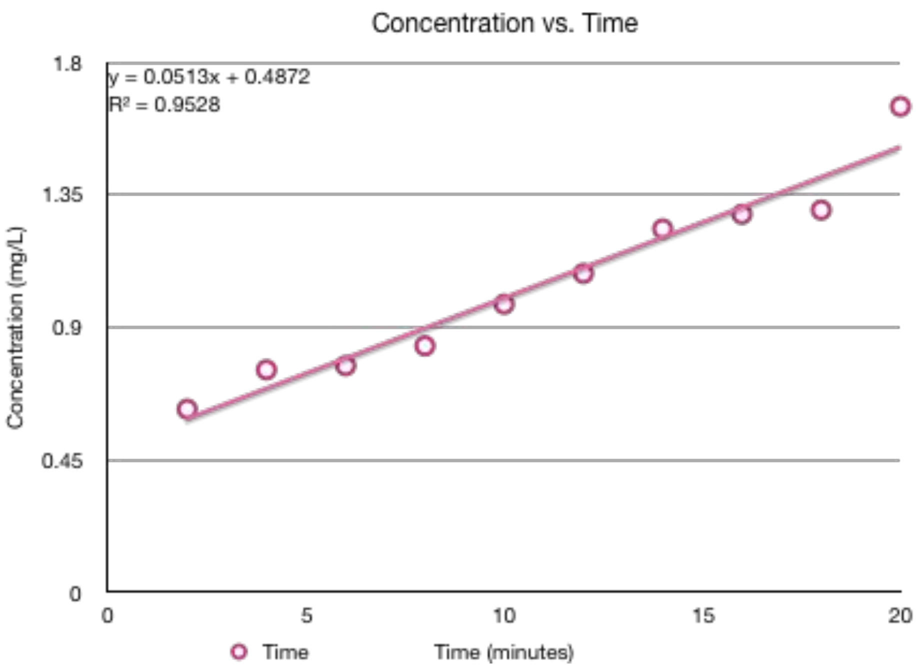
c (mg/L)	Calculated Absorbance	Actual Absorbance
1.649	1.596E-2	1.400E-2
8.369E-1	8.093E-3	6.000E-3
7.695E-1	7.441E-3	5.000E-3
6.219E-1	6.012E-3	4.000E-3
9.785E-1	9.462E-3	7.000E-3
7.555E-1	7.306E-3	5.000E-3
1.233	1.193E-2	1.000E-2
1.283	1.241E-2	1.000E-2
1.083	1.047E-2	8.000E-3
1.298	1.212E-2	1.000E-2

Line of best fit: y=0.00967x - 0.0022

Beer-lambert's Law: $A = \varepsilon l c$ $\varepsilon l = 0.00967$

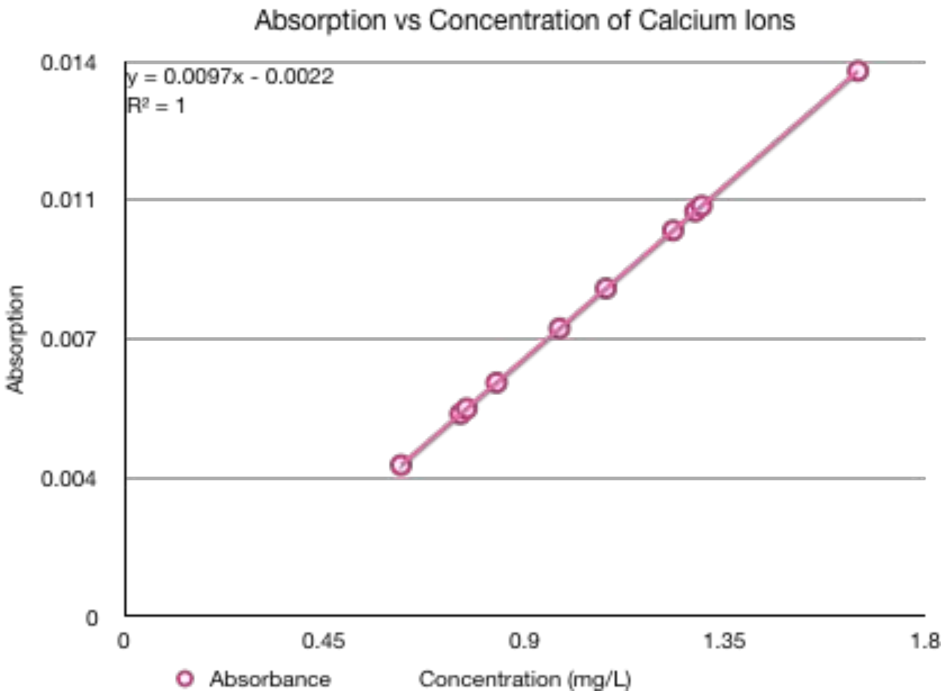
$A = (0.00967)\, c$

Experimental Errors



Errors in dilutions and calibrations

Data



Concentration (mg/L)	Absorbance
0.6219	3.813E-3
0.7555	5.106E-3
0.7695	5.241E-3
0.8369	5.893E-3
0.9785	7.262E-3
1.083	8.271E-3
1.234	9.732E-3
1.284	1.021E-2
1.298	1.035E-2
1.650	1.375E-2

Results

A linear regression was performed on our collected experimental data. The regression is $Y = 0.0097X - 0.0022$ where Y represents absorbance and X represents concentration.

The line showed an upward trend, indicating a decline in the filter's ability to collect calcium ions.

Conclusion

Hence, our hypothesis is correct. With every usage, the Brita filter showed less effectiveness in removing calcium ions. Consequently, the company producing Brita filters must inform consumers of of deterioration in filter performance and advise on the frequency of the filter replacement.

References

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