

SI Environmental Science - Full Discipline Demo

Determination of Water Hardness Using a Titrator

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Environmental Science - Full Discipline Demo
Course	SI Environmental Science - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match each term to the best description.

Terms to match:

- Ca^{2+}
- Titration
- EBT
- EDTA
- CaCO_3

Descriptions to match:

1. Reacts with carbon dioxide dissolved in water to form metallic ions
2. Metallic ion commonly found in hard water
3. Indicator that appears purple-pink in solutions containing metallic ions
4. Organic acid that strongly bonds and holds on to metallic ions
5. Quantitative, volumetric technique used to determine the concentration of a solution

Correct answers:

1 CaCO_3 2 Ca^{2+} 3 EBT 4 EDTA 5 Titration

Classify each statement as true or false.

⚡ Water hardness levels are consistent throughout the United States. ⚡ Water with greater than 180 ppm of CaCO_3 is considered very hard. ⚡ Ca^{2+} and Mg^{2+} are the most common ions found in hard water. ⚡ Soap and detergent effectiveness is enhanced by hard water.	
True	False
1	2

Correct answers:

- 1 Water with greater than 180 ppm of CaCO_3 is considered very hard.
 Ca^{2+} and Mg^{2+} are the most common ions found in hard water.
- 2 Water hardness levels are consistent throughout the United States.
Soap and detergent effectiveness is enhanced by hard water.

Exploration

Ca^{2+} and Mg^{2+} are released from minerals present in soil and rocks through reactions with ____ dissolved in rainwater.

- ☐ CO_2

☐ O_2

☐ NaCl

☐ NO_2

✓

Water supplies with 121-180 ppm of CaCO_3 are classified as ____ in the United States.

- ☐ soft
- ☐ moderately hard
- ☒ hard
- ☐ very hard



EBT changes to a ____ color at the end of a EDTA titration.

- ☐ orange
- ☒ blue-gray
- ☐ pink-purple
- ☐ green



Exercise 1

Would you classify your tap water hardness as soft, moderate, hard, or very hard? Reference your results reported in Data Table 2 and the table below in your explanation.

Classification	CaCO_3 concentration (ppm)
Soft	0-60
Moderately hard	61-120
Hard	121-180
Very hard	>180

Answers will vary by student; however, answers should match the hardness in the included table with results reported in Data Table 2.

From the provided information, the water at SI offices in Englewood, CO would be classified as very hard. The calculated ppm of CaCO_3 in our tap water was 290.17 ppm, which is greater than 180 ppm.

How do your tap water hardness test results compare to the water hardness map included in the Exploration of this lab? Reference the color of your location on the map in your answer. (Reference an area on the map that matches your test results if your sample was collected outside the U.S.)

Student test results should match the color categories on the map for the location where the tap water was collected. SI samples collected in Englewood, CO were classified as very hard which matches the red color on the location on the water hardness map.

Based on your water hardness test results, would you consider your plumbing and fixtures at risk of being damaged by prolonged exposure to hard water? Reference the effects of hard water exposure in your explanation.

Students should relate the risks of prolonged hard water damage to their results along with the damage that hard water incurs upon plumbing and fixtures. SI testing indicates pipes are subject to scaling and flow restriction and fixtures subject to residues that are difficult to remove.

Data Table 1: EDTA Titration Volume
(SAMPLE ANSWER BELOW)

Trial	Initial EDTA Volume (mL)	Final EDTA Volume (mL)	Total Volume EDTA Used (mL)
1	8.4	5.5	2.9
2	5.5	2.5	3.0
3	8.2	5.4	2.8
		Average Volume of EDTA Used (mL)	2.9

Data Table 2: Water Hardness
(SAMPLE ANSWER BELOW)

Concentration Ca^{2+} Ions Per Liter of Water (mol/L)	Water Hardness (ppm CaCO_3)
0.0029 (student results will vary based on location but should match data recorded in Data Table 1)	290.17

Competency Review

Hard water is caused by ____ released from soil minerals through reactions with carbon dioxide dissolved in rainwater.

- ☒ metallic ions ✓
- ☐ oxygen
- ☐ acids
- ☐ nitrogen

Hard water negatively impacts ____.

- ☐ soap effectiveness
- ☐ bathroom fixtures
- ☐ plumbing systems
- ☒ All of the above ✓

Water hardness is divided into four categories, depending on the concentration of calcium carbonate in the water.

- ☒ True ✓
- ☐ False

Water supplies in the ____ region of the U.S. are likely to have hard or very hard water.

- ☐ Northeast
- ☐ Southeast
- ☒ Southwest ✓
- ☐ Northwest

_____ is an indicator used in titrations for determining water hardness.

- ☐ EDTA
- ☒ EBT ✓
- ☐ CaCO_3
- ☐ MgSO_4

During an EDTA titration, _____ is added to the titrator.

- ☐ tap water
- ☐ indicator
- ☐ buffer
- ☒ EDTA ✓

Both the volume of the water sample and the volume of EDTA titrated are required to calculate the concentration of Ca^{2+} ions present in the sample.

- ☒ True ✓
- ☐ False

An EDTA titration of a tap water sample resulted in a calculated CaCO_3 concentration of 220 ppm. The water sample would be classified as _____.

- ☐ soft
- ☐ moderately hard
- ☐ hard
- ☒ very hard ✓

Extension Questions

EDTA is used in some industrial applications to remove metallic ions from solutions. Apply your knowledge to explain how EDTA titration could be used to determine the amount of EDTA required to remove metallic ions from a larger volume of solution. (SAMPLE ANSWER BELOW)

A sample of the solution could be placed in a beaker with EBT indicator and a buffer. EDTA could then be titrated into the beaker until the solution changed color, indicating that no more ions were

present. The volume of EDTA used in the titration could then be multiplied by the ratio of the titration sample volume: total solution volume to determine the amount of EDTA required to remove metallic ions from the large volume of solution.