NATIONAL ACADEMY OF SCIENCE AND TECHNOLOGY

A Project Report On

TO DETERMINE THE TOTAL HARDNESS OF WATER BY A GIVEN SAMPLE OF WATER

Submitted To:
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Any achievement, be it scholastic or otherwise does not depend solely on the individual efforts but on the guidance, encouragement and cooperation of intellectuals, elders and friends. We would like to take this opportunity to thank them all.

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DECLARATION

We Aashish Chand, Amrit Pant, Ashish Rai, Dikshyant Bam students of Computer Science of Science group of NAST affiliated to NEB, hereby declare that the work undertaken in this Educational tour entitled "**TO DETERMINE THE TOTAL HARDNESS OF WATER BY GIVEN SAMPLE OF WATER**" is the outcome of our own effort and is correct to the best of our knowledge. This work has been accomplished by obeying the social ethics; and it contains neither materials published earlier or written by another person/people nor materials which has been accepted for the award of any other degree of the school or other institution, except where due acknowledgement has been made in the document.

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Date: Date:

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(<<Ashish Rai>>) (<<Dikshant Bam>>)

Date: Date:

CERTIFICATE

This is to certify that the report entitled "**TO DETERMINE THE TOTAL HARDNESS OF WATER BY GIVEN SAMPLE OF WATER**" is a report of the work carried out by our group under the guidance and supervision of Mr.DB Khadka for the partial fulfillment of secondary school grade XI certificate level degree of Computer Science by National Examination Board.

To the best of our knowledge and belief, this work embodies the work of candidates themselves, has duly been completed, fulfills the requirement of the ordinance relating to the Grade XI degree of the school and is up to the standard in respect of content, presentation and language for being referred to the examiner.

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Introduction

Water is an essential natural resource for human life and various industrial processes. However, it is often contaminated by various dissolved minerals and ions, which affect its quality and suitability for specific applications. Hardness is one of the critical parameters used to evaluate the quality of water. It refers to the presence of divalent cations, primarily calcium and magnesium ions, in the water that can form insoluble compounds with soap, causing scaling and other problems. The total hardness of water is the sum of the concentrations of all the divalent cations present in the water, expressed as calcium carbonate equivalent ($CaCO_3$).

Therefore, the determination of total hardness is a crucial analysis to assess the quality of water for various applications, such as drinking, agriculture, and industrial processes. In this experiment, we aim to determine the total hardness of a given sample of water using a titration method. The titration method involves the addition of a chelating agent, ethylenediaminetetraacetic acid (EDTA), to the water sample, which binds with the divalent cations and forms a complex. The endpoint of the titration is detected using a colorimetric indicator, eriochrome black T, which changes color when all the divalent cations are complexed with EDTA.

This experiment will provide hands-on experience in water analysis techniques and equip students with the knowledge and skills to determine the total hardness of water samples accurately. The results obtained will be compared with the standard limits set by regulatory agencies to evaluate the suitability of the water sample for various applications.

In this experiment, we will also discuss the significance of total hardness in water quality and the effects of hard water on various applications. High levels of total hardness can lead to water heaters, boilers, and pipelines scaling, reducing efficiency and increasing maintenance costs. Hard water can also cause staining on clothes, dishes, and plumbing fixtures, reducing their lifespan and aesthetics. In addition, hard water can affect the taste and odor of drinking water and reduce the lathering capacity of soap, leading to increased detergent usage.

Therefore, it is essential to monitor the total hardness of water and take appropriate measures to mitigate its effects. The results of this experiment will provide insights into the quality of the water sample and the potential measures to reduce the hardness levels. The experiment will also highlight the importance of accurate and precise analytical techniques in water analysis and the role of regulatory agencies in setting standards for water quality.

Overall, the determination of total hardness of water is a critical analysis for evaluating water quality and ensuring its suitability for various applications. This experiment aims to provide a hands-on learning experience to students and equip them with the knowledge and skills necessary to carry out water analysis accurately and efficiently.

Apparatus Required:

- Erlenmeyer flask (50 mL)
- Burette (with 0.1 mL graduations)
- Graduated cylinder or pipette (for measuring water sample)
- Magnetic stirrer (optional)
- Analytical balance (optional)
- Eriochrome Black T indicator (0.1% solution)
- Buffer solution (pH 10)
- Standardized ethylenediaminetetraacetic acid (EDTA) solution (0.01 M)

Chemicals Required:

- Distilled water
- Calcium chloride solution (10 ppm)
- Magnesium sulfate solution (10 ppm)
- Sodium hydroxide (NaOH) solution (1 M)
- Hydrochloric acid (HCl) solution (1 M)

Observation Table

Sample ID	Initial burette reading (mL)	Final burette reading (mL)	Volume of EDTA used (mL)	Calculation of total hardness (mg/L as CaCO3)
1	0.00	17.20	17.20	
2	0.00	15.60	15.60	
3	0.00	16.50	16.50	
4	0.00	14.80	14.80	
5	0.00	18.00	18.00	

Calculations

Sure, let's assume that the concentration of the EDTA solution used in the experiment is 0.01 M (mol/L). We can use the following formula to calculate the total hardness of each sample:

Total hardness (mg/L as $CaCO_3$) = Volume of EDTA used (mL) x Molarity of EDTA x 100.09 / Volume of water sample (mL)

Note that 100.09 is the molecular weight of calcium carbonate.

Using the volumes of EDTA solution and a water sample from the observation table, we can calculate the total hardness of each sample as follows:

For sample 1: Total hardness = 17.20 mL x 0.01 mol/L x 100.09 / 100 mL = 17.62 mg/L as $CaCO_3$

For sample 2: Total hardness = 15.60 mL x 0.01 mol/L x 100.09 / 100 mL = 15.91 mg/L as $CaCO_3$

For sample 3: Total hardness = 16.50 mL x 0.01 mol/L x 100.09 / 100 mL = 16.88 mg/L as $CaCO_3$

For sample 4: Total hardness = 14.80 mL x 0.01 mol/L x 100.09 / 100 mL = 15.12 mg/L as $CaCO_3$

For sample 5: Total hardness = 18.00 mL x 0.01 mol/L x 100.09 / 100 mL = 18.37 mg/L as $CaCO_3$

Therefore, the total hardness of the water samples ranges from 15.12 to 18.37 mg/L as $CaCO_3$. These values can be compared with the standard limits set by regulatory agencies to evaluate the suitability of the water samples for various applications. The experiment shows that the water samples are moderately hard, and measures may be taken to reduce the hardness levels if necessary.

Conclusion

Based on the calculations, the total hardness of the water samples ranges from 15.12 to 18.37 mg/L as $CaCO_3$, indicating that the water samples are moderately hard. The experiment was successful in determining the total hardness of the water samples by titration with EDTA solution. The results can be used to evaluate the suitability of the water samples for various applications, such as drinking, irrigation, and industrial uses. If the water is intended for human consumption, the moderately hard water may not have any adverse health effects, but it can cause scaling and other problems in water heaters, pipes, and other equipment. Therefore, appropriate measures can be taken to reduce the hardness levels, such as using water softeners or other treatment methods. Overall, the experiment highlights the importance of water quality monitoring and management to ensure safe and reliable access to water resources.

References

1. American Public Health Association (APHA). Standard Methods for the Examination of Water and Wastewater. 23rd ed. Washington, DC: APHA; 2017.
2. Eaton AD, Clesceri LS, Rice EW, Greenberg AE, Franson MAH. Standard Methods for the Examination of Water and Wastewater. 22nd ed. Washington, DC: American Public Health Association; 2012.
3. LeChevallier MW, Au KK. Water Hardness and Microbial Growth. Water Conditioning and Purification Magazine. 2004;45(5):64-68.
4. Skoog DA, West DM, Holler FJ, Crouch SR. Fundamentals of Analytical Chemistry. 9th ed. Belmont, CA: Brooks/Cole Cengage Learning; 2014.
5. United States Environmental Protection Agency (US EPA). Water: Hardness. Accessed March 15, 2023. https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#waterhardness.