Short Communication

Mathematical Treatment to Understanding the Concentration Terms

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ABSTRACT

Concentration of solutions issues are among the foremost necessary and at that time one amongst the foremost difficult topics in general chemistry. The aim of this study is to work out the concentration of the solutions in the mole concept and stoichiometry that students typically performing the calculations associated with concentration such as molarity, normality etc. The study concerned school and under graduate students have learned the ideas of mole and concentration of solutions before the study. Mastery of the mole concept thought is foundational to understanding concentration of solutions. Specifically, students faced difficulties understanding the utilization. In this paper the scarcity of simple mathematical treatment to understanding the preparation of a concentration solutions viz. Molar, Normal etc. thought seemed to lead students to suppose the utilization of the simple mathematical formulae and steps to resolve the queries.

Keywords: Molarity, Normality, Mole, Molar mass

INTRODUCTION

Due to its abstract, theoretical nature, the mole concept and concentration terms has been recognized as one of the most difficult topics to teach, learn and implied within the chemistry curriculum. [8] The purpose of this study or paper is to chronical the development of high school and under graduate students, understanding the concentration terms. An analysis of the chemistry textbooks presentation of the mole concept and concentration terms and a comparison to the teacher's instructional techniques are discussed. Student's understandings of the preparation of solutions and mole concept are examined in relation to the textbook presentation and teachers influences. The findings indicate that students may fail to construct meaningful understandings of the concentration terms and it's preparation for the following reasons Inconsistency between the instrumental approaches of the textbook and teacher, Confusing terms vocabulary, Student's math anxiety and proportional reasoning ability, Lack of practice in problem solving. Stoichiometry problem solving is an area which poses a great challenge to students in chemistry learning. The difficulties may due to the capabilities of human learning and the abstract nature of the subject. Besides, chemistry educators and chemistry textbooks often present chemistry knowledge over at least three levels of representation as macroscopic, submicroscopic, and symbolic. [9] The mole concept (amount of substance) is a concept that connects the macro-world with the micro-world. [10] Many students treat the mole concept & the concentration of solutions as separate entities & their knowledge in these areas are always compartmentalized. In the several chemistry courses, secondary education does not result in the students relating the idea of "amount of substance" with counting particles. Instead, they identified the "amount of substance" with mass and occasionally, with volume. Meanwhile, students faced difficulties when the stoichiometric proportion in a reaction was not 1:1. This led to the challenge where students deal with laboratory reagent or solutions, because they could not consider that in diluting the aqueous solution of a substance, the volume of the solution changes. Highlighted difficulties faced by students in solving problems related to the concentration of solutions. Some observations studies have shown, how difficult the topic of solutions proves to be all levels of the high school and under graduate education. Various studies have been carried out regarding student's understanding of the mole concept as well as the concentration of solutions; there is a lack of explicit investigation linking both concepts. Factors such as basic understanding & problem solving skills contribute to students' performance in calculating problems related to the concentration of solutions. It is an observation of the some student's display improper understanding of the mole concept as well as concentration which always leads to the improper use of the mathematical formula. As such, the aim of this research was to examine college students' written calculations when trying to solve problems related to the concentration of solutions. [6]

This paper is largely concerned with measurement of concentration of various solutions viz. Molar, Normal etc. [1] The term concentration refers to the amount of solute present in a given solvent or solution. [1,12] The amount can be measured in many ways, there are many ways of measuring concentration of any solute in a given solution. In this paper we have mentioned concentrations term and sophisticated methods for concentration measurement. Concentration measurement is of crucial importance. Normality: Concentration of the solution expressed in number of equivalent per litre of solution is called Normality [7]

Normality (N) = Number of equivalent / litre of solution [11]

Molarity: Number of moles of solute present per litre of the solution is called Molarity [1]

Molarity = Moles of a Solute / litre of solution

If 0.1 mole of Solute is present in 100 ml (0.1 lit) solution then their molarity is equal to 0.1/0.1 = 1 M. The Analytical Molarity of a solution gives the total number of a solute in 1 litre of the solution. [3] Thus analytical molarity specifies the amount by which the solution can be prepared. Sulphuric acid solution that has analytical concentration of 1 mol per litre can be prepared by dissolving 1.0 mole or 98 g of sulphuric acid in 1 litre of solution. The equilibrium molarity express the molar concentration of particular species in a solution at equilibrium. In order to specify the equilibrium molarity of a particular species, if it necessary to know how the solute behaves when it is dissolved in a Solvent. [5]

If analytical molarity of NaOH is 0.1 M, then equilibrium molarity of NaOH, [NaOH] = 0.1M (Assuming 100% ionization) that of OH^-, $[OH^-]$ = 0.1 m and that of Na^+ $[Na^+]$ = 0.1M

$NaOH \text{ -------}\rightarrow Na^+ + OH^-$

If H_2SO_4 ionizes as

$H_2SO_4 \text{ -------}\rightarrow H^+ + HSO_4^-$

Then 0.1 M H_2SO_4 (Analytical) has equation concentration as (assume 100% ionization) [2]

$[H_2SO_4]$ = 0.0 M

$[H_2SO_4^-]$ = 1.0 M, H^+ as $[H_3O^+]$ = 1.0 M

However there is no difference between analytical & equilibrium molarity when solute dissolved is non-electrolyte or no ionization takes place in solution. [4]

1 M Urea = Non-electrolyte

1 M Glucose = Non-electrolyte

RESULT AND DISCUSSION

1. W = C x m x V (lit) ----- solid solute
W = given weight of a solute
m = Molar mass of a solute
C = Concentration of a solute
V= Volume of a solution in litre

2. W= C x $\frac{m}{d}$ x V (lit) ------liquid Solute
m = Molar mass of a solute
d = density of a liquid solute

Molarity (M):

W = M x m x V (lit)
W = M x $\frac{m}{d}$ x V (lit)

a) 0.1 M NaOH (200 ml)
W = 0.1 mole $litre^{-1}$ x 40 g/mole x 0.2 lit
W = 0.8 g
0.8 g of the NaOH dissolved in 200 ml of a solvent. Its molarity is 0.1

b) 0.5 M $Na_2S_2O_3$ (500 ml)
W = 0.5 mole/ lit x 158.11 g/mole x 0.5 lit
W = 339.527 g
39.527 g of the $Na_2S_2O_3$ dissolved in 0.5 lit of a solvent. The molarity is 0.5

c) 0.2 M H_2SO_4 (400 ml)
W = 0.2 mole/lit x $\frac{98\ g/mole}{1.84\ g/ml}$ x 0.4 lit.
W = 3.913 ml
3.913 ml of the H_2SO_4 dissolved in 400 ml of solvent, we get 0.2 Molar H_2SO_4.

***Normality (N)*:**

W = N x m′ x V (lit)
W = N x $\frac{m'}{d}$ x V (lit)

m′ (Equivalent weight) = $\frac{Molar\ \ mass}{Acicity\ \ or\ basicity}$

m′ = $\frac{m'}{Basicity}$ .... For Acid

m′ = $\frac{m'}{Acicity}$ .... For Base

m′ = $\frac{m'}{no.of\ electrons\ \ transfer}$ ---------For Oxidizing agent or Reducing agent

a) 0.1 N $Na_2S_2O_3$ (500 ml)
Equivalent Weight = $\frac{m}{no.of\ \ cations}$
= $\frac{158.11}{2}$
= 79.055 geq^{-1}
W = N x m′ x V (lit)
= 0.1 x 79.055 x 0.5
W = 3.952 g
3.952 g of the $Na_2S_2O_3$ dissolved in 500 ml, we get 0.1 N $Na_2S_2O_3$ solution.

b) 0.1 N $KMnO_4$ (500ml)
Equivalent Weight = $\frac{m}{no.of\ electrons\ \ loss\ or\ gain}$
= $\frac{158.032}{5}$
= 31.6064 geq^{-1}
W = N x m′ x V (lit)
= 0.1 x 31.6064 x 0.5
W = 1.58032 g
1.58032 g of the $KMnO_4$ dissolved in 500 ml, we get 0.1 N $KMnO_4$ solution.

c) 0.2 N H_2SO_4 (400 ml)
Equivalent Weight = $\frac{m}{basicity}$
= $\frac{98}{2}$
= 49 geq^{-1}
W = 0.2 mole/lit x $\frac{49\ g/mole}{1.84\ g/ml}$ x 0.4 lit.
W = 2.1304 ml
2.1304 ml of the H_2SO_4 dissolved in 400 ml of solvent, we get 0.2 Normal H_2SO_4.

CONCLUSION

The mathematical formula treatment is simple to understanding the preparation of concentrated solutions as compared to other various methods. By following this method, chemist will accurately prepare laboratory solution. It is also helpful to high school, Under Graduate & Post Graduate students.

REFERENCES

1. George Gorin. The definition and symbols for the quantity called “molarity “or “concentration “and for the SI units of this quantity. *J. Chem. Educ.*, 1985, 62(9), p 741.
2. Michael N. Quigley. Student preparation of standard solutions. *J. Chem. Educ.*, 1991, 66(6), p 505.
3. B.W. Smith and M. L. Parsons. Preparation of Standard solutions, *J. Chem., Educ.*, 1973, 50(10), p-679.
4. D.M. Harrison and C.J. Garratt. The accurate measurement of insulin molarity. *Biochem J.* 1969 Jul, 113(4): 733-734.
5. John F. Penrose. A practical application of molality. *J. Chem., Educ.*, 1983, 60(1), p-63.
6. Asghar Ghasemi & Saleh Zahediasl. Normality tests for statistical analysis; a guide for Non-statisticians, *Int., J Endocrinol Metab*, 2012 spring; 10(2): 486-489.

7. Jason P. Lott, MD, MHS, MSHP. A note on Normality. *JAAD*, June 2015, volume 72, Issue 6, pages e169-e170.
8. S. Novick, and J Menis. A study of student perceptions of the mole concept. *J. Chem., Educ.*, 1976, 53(1), p 720.
9. Sticky Wicket. The mole. *Journal of cell science,* 2002 115: 4389-4390; 10. 1242jcs.00192.
10. Lorence P. Eblin. The mole concept in Chemistry. *J. Chem., Educ*., 1962, 39(9), p 488.
11. Barbara B. Nelson. Testing for Normality. *Journal of Quality Technology, A Quarterly Journal of methods, applications and related topics,* Volume 15, 1983, Issue-03, p-141-143 (2018).
12. Keya Rani Das and A. H. M. Rahhmatullah Imon. A Brief Review of Tests for Normality. *American Journal of Theoretical and Applied Statistics,* Vol. 5, No. 1, 2016, pp 5-12.

How to cite this article: Jadhav VR, Nair sSG, Rayate MM et.al. Mathematical treatment to understanding the concentration terms. International Journal of Research and Review. 2019; 6(1):172-175.

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