Unit 4: Properties of Solutions

Representation of Concentration

This worksheet will cover the fundamental concept of concentration representation in chemistry, offering insights into quantities of substances within solutions. It will delve into commonly used measures like Molarity (M) and the Dilution Equation ($M_1V_1 = M_2V_2$), which adjusts solution concentration. Molality (m), Normality (N), and percent concentration will also be explored, providing diverse tools for expressing concentration based on moles, equivalents, or percentages. Understanding mass, volume, and parts per million (ppm) and parts per billion (ppb) for dilute solutions will be emphasized, enabling precise descriptions of solution composition in scientific research and experiments.

1. What does Molarity (M) represent in a solution?

2. Which equation is used to calculate the final concentration of a solution after dilution?

3. What does "ppm" stand for in chemistry when referring to concentration?

4. When dealing with very dilute solutions, which concentration unit is typically used to represent extremely low concentrations?

5. Define Normality (N) in terms of concentration and provide an example of when it is used.

6. Calculate the mass percent of solute in a solution if 40 grams of salt (NaCl) is dissolved in 160 grams of water (H_2O).

7. You have a solution with a molarity of 0.5 M, and you need to prepare 250 mL of a more dilute solution with a final molarity of 0.2 M. Calculate the volume of the original 0.5 M solution you should use and explain the steps involved.

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ANSWER KEY:

1. What does Molarity (M) represent in a solution?

Molarity represents the number of moles of solute per liter of solution. M = moles/Liters

2. Which equation is used to calculate the final concentration of a solution after dilution?

The Dilution Equation ($M_1V_1 = M_2V_2$) is used to calculate the final concentration (M_2) of a solution after dilution. The dilution equation is used often to prepare stock solutions, dilutions, and serial dilutions as well.

3. What does "ppm" stand for in chemistry when referring to concentration?

"ppm" stands for "parts per million" and is used to express concentration as a ratio of one part of solute to one million parts of the solution. Oftentimes, one will see these units used in terms of applications like environmental monitoring to measure the amount of pollutants in the soil, air and water, for instance.

4. When dealing with very dilute solutions, which concentration unit is typically used to represent extremely low concentrations?

Parts per billion (ppb) is commonly used to represent extremely low concentrations, especially when the amount of solute is significantly smaller compared to the total mass or volume of the solution.

5. Define Normality (N) in terms of concentration and provide an example of when it is used.

Normality (N) is a measure of concentration that takes into account the number of equivalents of solute in a solution. It is used in acid-base titrations when the reaction involves multiple acidic or basic sites. For example, in the titration of sulfuric acid (H_2SO_4), which has two acidic hydrogens, the normality would be twice the molarity.

6. Calculate the mass percent of solute in a solution if 40 grams of salt (NaCl) is dissolved in 160 grams of water (H_2O).

Answer: Mass percent = (mass of solute / total mass of solution) x 100%
Mass percent = (40 g / (40 g + 160 g)) x 100%
Mass percent = (40 g / 200 g) x 100%
Mass percent = 20%

7. You have a solution with a molarity of 0.5 M, and you need to prepare 250 mL of a more dilute solution with a final molarity of 0.2 M. Calculate the volume of the original 0.5 M solution you should use and explain the steps involved.

To dilute a solution from 0.5 M to 0.2 M while keeping the moles of solute constant, you can use the formula for dilution:
$(M_1)(V_1) = (M_2)(V_2)$

Where:

- M_1 = Initial molarity (0.5 M)
- V_1 = Volume of the initial solution (unknown)
- M_2 = Final molarity (0.2 M)
- V_2 = Final volume (250 mL or 0.25 L)

Rearrange the formula to solve for V_1:
$V_1 = (M_2)(V_2) / M_1$
$V_1 = (0.2\ M)(0.25\ L) / 0.5\ M$
$V_1 = 0.1$ L or 100 mL
Therefore, you should use 100 mL of the 0.5 M solution and dilute it with enough solvent (e.g., water) to make the final volume 250 mL to achieve a final molarity of 0.2 M.