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The field of chemistry involves a variety of methods for measuring and analyzing substances. Among the most fundamental concepts in quantitative analysis are primary and secondary standard substances. These standards play a vital role in ensuring the accuracy of measurements and results in various chemical experiments and analyses. Basic Concepts Primary Standard Substances Primary standard substances are highly pure, stable, and reliable substances used for calibrating and standardizing measurement instruments in quantitative chemical analysis. They possess certain characteristics, such as known stoichiometry, high purity (typically >99.9%), stability against air and moisture (non-hygroscopic), and high solubility in the relevant solvent. Examples include potassium hydrogen phthalate (KHP) for acid-base titrations and potassium dichromate ($K_2Cr_2O_7$) for redox titrations. Secondary Standard Substances Secondary standard substances are substances whose concentration is determined by titration against a primary standard substance. These substances may not possess the same high purity as primary standards, and their properties may change over time; therefore, their quality must be checked regularly. Their concentration is not known with the same level of certainty as primary standards. An example could be a solution of sodium hydroxide (NaOH), which is often standardized against a primary standard like KHP. Equipment and Techniques Equipment Essential equipment in using primary and secondary standards includes analytical balances, volumetric flasks, pipettes (volumetric and graduated), burettes, and titration vessels (e.g., Erlenmeyer flasks). All of this equipment must be properly calibrated and maintained to ensure the accuracy of measurements. Cleanliness is crucial to avoid contamination. Techniques Key techniques involve titration (acid-base, redox, complexometric), gravimetric analysis, and instrumental analysis (e.g., spectrophotometry). The choice of technique depends on the specific requirements of the experiment or analysis and the properties of the analyte. Types of Experiments Acid-Base Titration One of the most common experiments involving primary and secondary standards is acid-base titration, where the concentration of an acidic or basic solution is determined using a primary standard to standardize the titrant (e.g., standardizing NaOH solution with KHP). Redox Titrations In redox titrations, primary and secondary standards can be used to determine the oxidizing or reducing capabilities of different substances. For example, potassium permanganate ($KMnO_4$) solutions can be standardized against sodium oxalate ($Na_2C_2O_4$). Data Analysis In data analysis, the values obtained from the use of primary and secondary standard substances help in determining the concentration, purity, and other characteristics of various substances. This data is then used to calculate the results of the experiment and draw conclusions about the specific chemical reactions or processes being studied. Proper error analysis is essential. Applications Primary and secondary standards have numerous applications in fields like pharmaceuticals (drug assays), environmental science (water quality analysis), materials science (compositional analysis), and food chemistry (nutritional analysis). They are used extensively in quality control, research and development, and regulatory compliance. Conclusion Understanding the role and proper use of primary and secondary standard substances is key to carrying out accurate and reliable quantitative chemical analyses. They are fundamental tools in the vast and varied field of chemistry, contributing significantly to its many applications in science, industry, and everyday life. Standardization refers to finding the exact concentration of a prepared solution using a standard solution as the reference. Standard solutions are solutions of accurately known concentrations, prepared using standard substances. There are two types of standard solutions known as primary solution and secondary solution. A primary standard solution is a solution with a high purity and less reactivity. A secondary standard is not that pure and is chemically reactive than primary standards. This is the main difference between primary and secondary standard solution. Key Areas Covered 1. What is a Primary Standard Solution – Definition, Specific Properties, Examples 2. What is a Secondary Standard Solution – Definition, Properties, Examples 3. What is the Difference Between Primary and Secondary Standard Solution – Comparison of Key Differences Key Terms: Hygroscopic, Primary Standard, Reference Material, Secondary Standard, Solvent, Standardization What is a Primary Standard Solution Primary standard solutions are solutions made out of primary standard substances. A primary standard is a substance of known high purity (99.9% pure) which may be dissolved in a known volume of solvent to give a primary standard solution. Primary standards are reagents that can involve in chemical reactions. These compounds are often used to determine the unknown concentration of a solution that can undergo a chemical reaction with the primary standard. Primary standards comprise special chemical and physical properties. These compounds are extremely pure and highly stable. Therefore, we can obtain pure solutions using these compounds. For example, if we want to prepare a standard solution of 0.1 molL-1 concentration, we can calculate the weight of the primary standard required for this and then dissolve that amount in a suitable solvent. This gives exactly the 0.1 molL-1 solution with a high purity. Standardization of solutions is a concept of analytical chemistry that is required for the accuracy of a titration. Before we use any solution in a titration process, all the solutions should be standardized with a primary standard solution. This is because, even though we weigh the exact amount of a compound that is required to prepare a 0.1 molL-1 solution, it will not give the exact concentration (due to the presence of impurities). However, since the concentration of the primary standard solution is 99.9% accurate, we can titrate the prepared solution with a suitable primary standard solution to find the exact concentration of the prepared solution. Figure 1: Standardization is done as a Titration Primary standards are highly pure due to their low reactivity. If these compounds were highly reactive, they could get contaminated with many other chemicals, forming impurities. Primary standards are less hygroscopic. Therefore they do not absorb moisture from the air in considerable amounts. This also makes the primary standards highly pure compounds. Examples of Primary Standard Solutions and their Applications Solution Application Potassium bromate ($KBrO_3$) Used for the standardization of sodium thiosulfate solutions Sodium chloride (NaCl) Used as a primary standard for silver nitrate Zinc powder Used to standardize EDTA solutions A secondary standard solution is a solution that is made specifically for a certain analysis. A secondary standard is a substance whose active agent contents have been found by comparison against a primary standard. This means it is usually standardized against a primary standard. Secondary standard solutions are used to calibrate analytical equipment and analytical techniques. These solutions do not fulfill the requirements of a primary standard. A secondary standard has a less purity than a primary standard. These are less stable and chemically reactive than primary standards. Therefore these compounds can get contaminated. Figure 2: Potassium permanganate solution is a secondary standard solution. Anhydrous sodium hydroxide is a secondary standard. It is highly hygroscopic. Potassium permanganate is another compound that is often used as a secondary standard. It is less stable and is reactive. Therefore when a Potassium permanganate solution is being prepared, it has to be standardized with a primary standard. Definition Primary Standard Solution: Primary standard solutions are solutions made out of primary standard substances. Secondary Standard Solution: Secondary standard solutions are solutions made specifically for a certain analysis. Purity Primary Standard Solution: Primary standard solutions are extremely pure (about 99.9%). Secondary Standard Solution: Secondary standard solutions are not very pure. Reactivity Primary Standard Solution: Primary standards are less or not reactive. Secondary Standard Solution: Secondary standards are reactive than primary standards. Water Absorption Primary Standard Solution: Primary standards are not hygroscopic. Secondary Standard Solution: Secondary standards are somewhat hygroscopic. Applications Primary Standard Solution: Primary standard solutions are used to standardize secondary standards and other reagents. Secondary Standard Solution: Secondary standard solutions are used for specific analytical experiments. Conclusion Standard solutions can be divided into two groups as primary standard solutions and secondary standard solutions. Primary standard solutions are solutions made out of primary standard substances. Secondary standard solutions are not as pure as primary standard solutions. Purity is the main difference between primary and secondary standard solution. References: 1. Helmenstine, Ph.D. Anne Marie. "Learn About Primary and Secondary Standards in Chemistry." ThoughtCo, Available here.2. "Standard solution." IUPAC Gold Book, Available here.3. Libretexts. "5.1: Analytical Standards." Chemistry LibreTexts, Libretexts, 23 Dec. 2016, Available here. Image Courtesy: 1. "Titration Apparatus" By Ivan Akira – Own work (CC BY-SA 3.0) via Commons Wikimedia2. "Kmno4-oldva" By Naszy – Saját kép (CC BY-SA 2.5) via Commons Wikimedia Standardization refers to finding the exact concentration of a prepared solution using a standard solution as the reference. Standard solutions are solutions of accurately known concentrations, prepared using standard substances. There are two types of standard solutions known as primary solution and secondary solution. 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"Titration Apparatus" By Ivan Akira – Own work (CC BY-SA 3.0) via Commons Wikimedia2. "Kmno4-oldva" By Naszy – Saját kép (CC BY-SA 2.5) via Commons Wikimedia A secondary standard solution is a chemical term that refers to a solution that has its concentration measured by titration with a primary standard solution, explains EasyChem.com. The amount of chemical reactants in the primary standard solution is known beforehand. Mathematical equations determine how many ions are in a secondary standard solution.The main reason for making a secondary standard solution is to make one solution of an exact concentration. For instance, some substances, such as hydrochloric acid, vary concentrations with time. To make a standard hydrochloric acid solution, chemists take an approximate concentration of acid and titrate a suitable solution, such as sodium carbonate, into the hydrochloric acid. An exact concentration is then calculated after the titration is complete.An indicator changes color marks when the titration is complete. Bromothymol blue, methyl orange or phenolphthalein are liquids that change color when a certain concentration is reached. When the titration is complete, stoichiometric calculations are used to determine the concentration of the secondary standard solution. Stoichiometry takes into account molecular weights and chemical formulas of reactants to determine mass and volume of solutions.A primary standard solution is prepared by directly weighing the substances dissolved in a precisely measured solvent. A primary standard solution is considered pure, and the concentration of such substances are known before titration into a secondary standard solution. MORE FROM REFERENCE.COM Secondary Standard Substance : The substance which can not kept on open place and they easily react with the components of air (O_2, CO_2 etc.), react with balance when they are weighting are called Secondary Standard Substance. e.g. HCL, H_2SO_4, NaOH, KOH, $KMnO_4$, etc. are the Secondary Standard Substance. What is meant by secondary standard in chemistry? A secondary standard is a chemical or reagent which has certain properties. such as. (a) It has less purity than primary standard. (b) Less stable and more reactive than primary standard. (c) But its solution remains stable for a long time. A primary standard is an ultrapure compound that serves as the reference material for a titration or for another type of quantitative analysis. A secondary standard is a compound whose purity has been determined by chemical analysis. See also How do E2 reactions affect stereochemistry?What is difference between primary standard and secondary standard? 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Materials that contain the substance of interest at a known concentration are called biological standards. Units of measurement can also be specified. New material can be tested using this standard to determine its concentration. Primary standards are therefore used as primary calibrators or primary reference materials. Functions of these primary and secondary standardsThe standardization of volumetric solutionsThe purpose of this reference is to determine unknown concentrations using itThe preparation of secondary standardsCalibration of instruments.Primary standardsPrimary standards are chemicals or reagents that have particular properties, especially 1. This is an incredibly pure substancePrimary standard materials should have a high degree of purity, preferably 99.98%, meaning they must be a chemical that has been prepared from very pure materials. There are various grades of purity of chemicals in chemistry labs. The purity percentage appears on the label. It is a suitable material for primary standards when the chemical is pure to 99.98% or more.2. High level of stabilityIt should have a high degree of stability which means it will not easily react when it is pure. A more accurate expression would be that it should be relatively inert. If a reagent is unstable or changes its properties over time, it may not be reliable, since it reacts easily with air, water, or other molecules. Unreliable and unstable chemicals cannot ever be used as standards.3. As anhydrous as possibleSalt should be anhydrous, meaning that its molecular structure contains no water molecules.4. There is less hygroscopicityHaving anhydrous properties is not enough. It is preferable if the chemical is less hygroscopic than water molecules are absorbed when the container is opened.5. The molecular weight of this substance is very high6. Easy to weighThe pure nature of the material allows it to be weighed easily since its weight is a true representation of its actual molecular weight.7. It must be available and ready for use8. Ideally, it should be nontoxic9. It shouldn't cost too muchSecondary standardsLaboratory standards such as those involved in producing chemicals, reagents, kits, or producing quality control materials for other businesses are considered secondary standards. Primary standards are used as primary calibrators or primary reference materials. Additionally, secondary standards are used in smaller labs for the calibration of control materials, which is used for analyzing unknown concentrations of substances. As such, secondary standards function primarily to perform external quality control on smaller laboratories. To apply the secondary standard to the primary standard, it must be standardized and compared. To prepare the secondary standard solution, an aqueous solution of high purity must be used. Water must be deionized when used as an aqueous solvent. Standard solutions prepared without pure solvent are worthless (These points apply to primary standard solutions as well). Similarly, individuals should check dates of manufacture, expiration dates, dates of receipt of high-grade chemicals, whether the conditions for their transport were followed or not, whether the seal has been damaged, its purity, and whether a standard reference material was used before using them.Chemicals and reagents classified as secondary standards have certain properties, for instanceCompared to the primary standard, it is less pureStability and responsiveness are less than primary standardsThis solution, however, remains stable for quite some timeA comparison has been made against primary standardsChemicals that meet the requirements for being standard chemicals, but do not meet those of primary standards Get subject wise printable pdf notesView Here Visitors are also reading: Standardization refers to finding the exact concentration of a prepared solution using a standard solution as the reference. Standard solutions are solutions of accurately known concentrations, prepared using standard substances. There are two types of standard solutions known as primary solution and secondary solution. A primary standard solution is a solution with a high purity and less reactivity. A secondary standard is not that pure and is chemically reactive than primary standards. This is the main difference between primary and secondary standard solution. Key Areas Covered 1. What is a Primary Standard Solution – Definition, Specific Properties, Examples 2. What is a Secondary Standard Solution – Definition, Properties, Examples 3. What is the Difference Between Primary and Secondary Standard Solution – Comparison of Key Differences Key Terms: Hygroscopic, Primary Standard, Reference Material, Secondary Standard, Solvent, Standardization What is a Primary Standard Solution Primary standard solutions are solutions made out of primary standard substances. 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Before we use any solution in a titration process, all the solutions should be standardized with a primary standard solution. This is because, even though we weigh the exact amount of a compound that is required to prepare a 0.1 molL-1 solution, it will not give the exact concentration (due to the presence of impurities). However, since the concentration of the primary standard solution is 99.9% accurate, we can titrate the prepared solution with a suitable primary standard solution to find the exact concentration of the prepared solution. Figure 1: Standardization is done as a Titration Primary standards are highly pure due to their low reactivity. If these compounds were highly reactive, they could get contaminated with many other chemicals, forming impurities. Primary standards are less hygroscopic. Therefore they do not absorb moisture from the air in considerable amounts. This also makes the primary standards highly pure compounds. Examples of Primary Standard Solutions and their Applications Solution Application Potassium bromate ($KBrO_3$) Used for the standardization of sodium thiosulfate solutions Sodium chloride (NaCl) Used as a primary standard for silver nitrate Zinc powder Used to standardize EDTA solutions A secondary standard solution is a solution that is made specifically for a certain analysis. A secondary standard is a substance whose active agent contents have been found by comparison against a primary standard. This means it is usually standardized against a primary standard. Secondary standard solutions are used to calibrate analytical equipment and analytical techniques. These solutions do not fulfill the requirements of a primary standard. A secondary standard has a less purity than a primary standard. These are less stable and chemically reactive than primary standards. Therefore these compounds can get contaminated. Figure 2: Potassium permanganate solution is a secondary standard solution. Anhydrous sodium hydroxide is a secondary standard. It is highly hygroscopic. Potassium permanganate is another compound that is often used as a secondary standard. It is less stable and is reactive. Therefore when a Potassium permanganate solution is being prepared, it has to be standardized with a primary standard. Definition Primary Standard Solution: Primary standard solutions are solutions made out of primary standard substances. Secondary Standard Solution: Secondary standard solutions are solutions made specifically for a certain analysis. Purity Primary Standard Solution: Primary standard solutions are extremely pure (about 99.9%). Secondary Standard Solution: Secondary standard solutions are not very pure. Reactivity Primary Standard Solution: Primary standards are less or not reactive. Secondary Standard Solution: Secondary standards are reactive than primary standards. Water Absorption Primary Standard Solution: Primary standards are not hygroscopic. Secondary Standard Solution: Secondary standards are somewhat hygroscopic. Applications Primary Standard Solution: Primary standard solutions are used to standardize secondary standards and other reagents. Secondary Standard Solution: Secondary standard solutions are used for specific analytical experiments. Conclusion Standard solutions can be divided into two groups as primary standard solutions and secondary standard solutions. Primary standard solutions are solutions made out of primary standard substances. Secondary standard solutions are not as pure as primary standard solutions. Purity is the main difference between primary and secondary standard solution. References: 1. Helmenstine, Ph.D. Anne Marie. "Learn About Primary and Secondary Standards in Chemistry." ThoughtCo, Available here.2. "Standard solution." IUPAC Gold Book, Available here.3. Libretexts. "5.1: Analytical Standards." Chemistry LibreTexts, Libretexts, 23 Dec. 2016, Available here. Image Courtesy: 1. "Titration Apparatus" By Ivan Akira – Own work (CC BY-SA 3.0) via Commons Wikimedia2. "Kmno4-oldva" By Naszy – Saját kép (CC BY-SA 2.5) via Commons Wikimedia Standardization refers to finding the exact concentration of a prepared solution using a standard solution as the reference. Standard solutions are solutions of accurately known concentrations, prepared using standard substances. There are two types of standard solutions known as primary solution and secondary solution. A primary standard solution is a solution with a high purity and less reactivity. A secondary standard is not that pure and is chemically reactive than primary standards. This is the main difference between primary and secondary standard solution. Key Areas Covered 1. What is a Primary Standard Solution – Definition, Specific Properties, Examples 2. What is a Secondary Standard Solution – Definition, Properties, Examples 3. 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