Koh strong or weak acid or base

(Back to page 5 Anion) TABLE OF STRONG ACIDS Completely Ionized in water to give one (or more) protons per acid molecule HI H+(aq) + I-(aq) HBr H+(aq) + Br-(aq) HClo4 H+(aq) + CLO4-(aq) HCl H+(aq) + Cl-(aq) H CLO3 H+(aq) + CLO3-(aq) H2SO4 H+(aq) + HSO4-(aq) (HSO4- is a weak acid that contributes additional protons) HNO3 H+(aq) + NO3-(aq) TABLE OF STRONG BASES Completely Ionized in water to give one (or more) Hydroxide per Basic Molecule NaOH Na +(aq) + OH-(aq) KOH K+(aq) + OH-(aq) LiOH Li+(aq) + OH-(aq) RbOH Rb+(aq) + OH-(aq) CSOH Ks+(aq) + OH-(aq) + OH-(aq) Ca(OH)2 Ca2+(((((((aq) aq) aq) + 2OH-(aq) (but not very soluble) Ba(OH)2 Ba2+(aq) + 2OH-(aq) (but not very soluble) Sr(OH)2 Sr2+(aq) + 2OH-(aq) (but not very soluble) (For a list of common weak acids and bases , see Table 8-2 in Oxtoby) By the end of this section, you will be able to: Evaluate the strength of an acid or base based on disconnection in water. Apart from their names and types, so far we have treated all acids as equal. However, acids can be very different in a very important way. Consider HCl(aq). When HCl dissolves into H2O, it is completely separated into H+(aq) and Cl−(aq) ions. All HCl molecules are converted to ions: [latex]\large\text{HCl}\left(aq\right)+{\text{H}}_{2}\text{O}\left(l\right)\rightarrow {\text{H}}_{3}{\text {O}}{{{{{{{{{{{{{{{{{{{{{{{{{{{{{{\text{+}}\left(aq\right)+{\text{Cl}^{-}\left(aq\right)[/latex] (100% dissociation) Any acid that separates 100% into ions is called strong acid. HC2H3O2 είναι ένα παράδειγμα ασθενούς οξέος: [λατέξ]\μεγάλο \κείμενο{H}\κείμενο{C}_{2}\κείμενο{H}_{3}\κείμενο{O}_{2}\left(aq\right)+{\text{H}_{2}\text{O}\left(l\right)\rightarrow {\text{H}}___κείμενο {3}{\text{O}}^{\text{+}}\left(aq\right)+\text{C}_{2}\text{H}_{3}{\text{O}_{2}}^{-}\left(aq\right)[/latex] (~5% dissoχιση) Επειδή αυτή η αντίδραση δεν πηγαίνει 100% στην ολοκλήρωση, είναι πιο κατάλληλο να το γράψετε ως ισορροπία: [λατέξ]\μεγάλο \κείμενο{H}\text{C}_{2}\text{H}_{3}\text{O}_{2}\left(aq\right)+{\text{H}}_{2}\text{O}\left(l\right)\rightharleftpoons {\text{H}}_{3}{\text{O}}^{\text{+}}\left(aq\right)+\text{C}_{2}\text{H}_{3}{\text{O}_{2}}^{-}\left(aq\right)[/latex] Μόλις εμφανιστεί , there are very few strong acids, which are given in Table 1. If an acid is not mentioned here, it is a weak acid. It may be 1% ionized or 99% ionized, but it is still classified as a weak acid. The issue is similar to the bases: a strong base is a base that is 100% ionized in solution. If it is less than 100% ionized in the solution, it is a weak base. There are very few strong bases (see Table 1); any basis not mentioned is a weak base. All strong bases are OH– compounds. Thus, a basis based on a mechanism, such as NH3 (which does not contain OH− ions as part of the It's going to be a weak base. Table 1. Some common strong acids and strong bases strong acids strong bases HClo4 perchloric acid LiOH lithium hydroxide HCl hydrochloric acid NaOH sodium hydroxide HBr hydrobromic acid KOH potassium hydroxide HI hydrodic acid Ca(OH)2 calcium hydroxide H(OH)2 calcium hydroxide HNO3 nitric acid Sr(OH)2 strontium hydroxide H2SO4 sulphuric acid Ba(OH)2 barium hydroxide The forces of brønsted-Lowry acids and bases in aqueous solutions can be determined by how to separate them in water. Strong acid: There is 100 % separation in water. Strong base: There is 100 % separation in water. Weak acid: There is <100 % separation in water. Weak base: There is <100 % separation in water. Electrolytes are substances that, when dissolved in water, break down into cations (co-charged ions) and anions (minus charged ions). We say they ionize. Strong electrolytes completely ionize (100%), while weak electrolytes only partially ionize (usually in the order of 1-10%). (Salts are sometimes also called ion compounds, but really strong bases are ion compounds as well.) Weak electrolytes include weak acids and weak bases. Examples of strong and weak electrolytes are given below: Powerful electrolytes strong acidsHCl, HBr, HI, HNO3, HClo3, HClo4, and H2SO4 strong basesNaOH, KOH, LiOH, Ba(OH)2, and Ca(OH)2 saltsNaCl, KBr, MgCl2, and many, many more weak electrolytes weak acidsHF, HC2H3O2 (acid), H2CO3 (carbonic acid), H3PO4 (phosphoric acid), and many more weak basesNH3 (ammonia), C5H5N (pyridine), and many more, all contain N To be able to classify electrolytes is critical as chemicals , we need to be able to look at a formula like HCl or NaOH and quickly know which of these classifications it is in, because we need to be able to know what we are working with (ions or compounds) when we are working with chemicals. We need to know, for example, that a bottle marked NaCN (a salt) does not actually contain NaCN, rather Na+ and CN-, or that a bottle marked HCN (a weak acid) is mainly HCN with a small amount of H+ and CN- also present. The difference between just opening a bottle marked HCN and one marked NaCN could be your life, as HCN, or hydrogen cyanide, is a toxic gas, while CN-, or cyanide ion, is an ion, not a gas and is transported only in solid form or solution. Nevertheless It's cyanide ion, CN-, which is the killer. (Locks onto Fe3+ in hemoglobin, causing less oxygen to reach your brain.) Cyanide is present in both bottles, and if it is transferred to your blood either as CN- or as HCN, it will kill you. Six steps to categorization categorization How do we categorize associations by their type? A practical method is described below: Step 1It is one of seven strong acids; Step 2It is from the format Metal(OH)n? Then it's a strong base. Step 3Is it from the Format Metal(X)n? Then it's salt. Step 4Is guy starting with an H? It's probably weak acid. Step 5Is that it has a nitrogen atom? It could be a weak base. Step 6N one of them? Call it non-robbery. Note that there are ambiguities here starting with Step 4. That's the way it is. To determine whether a substance is a weak acid or weak base you need to know more than the molecular formula, especially for compounds containing carbon. (A structural formula, which shows the detailed connections of atoms is often necessary.) Summary In short, know the most common data names and symbols, memorize the seven strong acids, be able to locate a metal (know at least where they are in the periodic table), memorize at least some of the most common weak acids and weak base, and you will be in good shape. YOU CAN DO IT! When nitric acid is combined with potassium nitrate potassium hydroxide is formed: HNO3 + KOH KNO3 + H2O Fill in the following statements: K+ is the combined acid of the strong KOH base. NO3- is the coupling basis of strong HNO3 acid. A very weak acid or base will not affect the pH of an aqueous solution. If none of the salt ions cause a pH increase or decrease, the solution will be neutral. Good! A salt formed by the reaction of a strong acid and strong base will not act either as an acid or as a base. Salts of strong bases and weak acids When formic acid reacts with potassium hydroxide, sodium formate is formed: HCO2H + KOH KHC2 + H2O You have already found that K+ is the very weak paired acid of KOH and will not affect the pH of a solution. What about HCO2-? Fill in the following statements: HCO2- is the coupling base of the HCO2H weak acid. How will a weak base affect the pH of a solution? If cation does not affect pH and anion causes pH to increase, will the resulting solution be acidic or basic? Good! A salt formed by the reaction of a weak acid and strong base will act as a basis, causing the pH of a solution to increase. Salts of strong acids and weak bases When nitric acid reacts with ammonia, ammonium nitrate is produced: HNO3 + NH3 NH4NO3 You have already found that NO3- is the very weak coupling base of HNO3 and will not affect the pH of the solution. What about NH4+? Fill in the following statements: NH4+ is the coupling acid of the weak NH3 base. How will a weak acid affect the pH of a solution? If the cation causes the pH to decrease and the does not affect pH, the resulting solution will be acidic or basic; Good! A salt formed by the reaction of a strong acid and weak base will act as an acid, causing the pH of a solution to decrease. Page 2 2 salts as products as acid base reactions Determine whether an aqueous salt solution will be acidic, basic or neutral Understand how pH can affect soluentity The list of ingredients for almost any household product is sure to inlude at least one compound that chemists classify as salt. While you may think of salt as the white grains used to taste food (known by chemists as sodium chloride, NaCl), chemists classify many compounds as salts. For chemists, a salt is any ionic compound that could have been formed by an acid-based reaction. Sodium chloride fits this definition, since it could be formed by the reaction of hydrochloric acid and sodium hydroxide: HCl + NaOH NaCl + H2O When combining any acid and base, an exchange reaction occurs, producing salt and water. A general equation for this process is presented below: HA + BOH BA + H2O The negative salt ion (A-) is the coupling base of HA acid, while the positive salt ion (B+) is the paired acid of the BOH base. Depending on the strength of the acid and the base, the resulting solution may be acidic, basic or neutral. If the strengths of the original acid (HA) and the base (BOH) are known, the strengths of the paired acid and its base can be determined, since the ionization constants of the paired acid-base pairs are related: Ka x Kb = Kw = 1.0 x 10-14 Fill in the following statements: Good! This relationship is also observed with their bases and coupling acids. If BOH is a very strong base, B+ will be a very weak acid and will not affect the pH of a solution. If BOH is a weak base, B+ will be a weak acid and will cause a reduction in the pH of a solution. These relationships are summarized in the following table: Example Paired Base Strength of control base Affect pH Strong acid HNO3 NO3- Very weak No Weak Acid HCO2H HCO2- Weak Increase Example Paired Acid Strength of AcidSine Effect on pH Strong Base KOH K+ Very Weak No Weak Base NH3 NH4+ Weak Reduction A strong acid is what completely detects in water. Its ionization constant is too large to measure. If this is the case, the paired base will have an ionization constant that is incredibly small (too small to measure!) and can be classified as too weak. Assume that a weak acid has a ionization constant of 1.0 x 10-4. The ionization constant of its coupling base would be 1.0 x 10-10. How would you sort the power of this base? Now let's assume that a weak acid has a ionization constant of 1.0 x 10-11. The ionization constant of its coupling base would be 1.0 x 10-3. It would be the strength of this base. same ranking as the first example? Remember that a base (unless it is too weak) will cause the pH of a solution to increase. A very weak base will not affect the pH of the solution. Page 3 You may not know it, but you experience the chemistry of acids and bases every day. Have you done any of the following baked anything containing baking soda or baking powder? taken antacids for stomach disorders; unclogged your sink with a drain cleaner like drano™? used carbon-free copy paper (such as credit card receipt signature)? These are just a few everyday examples of acid-based chemistry. Even if you never make any of the above examples, you cannot escape the chemistry of acids and bases. Along with water, the main substances of your muscles, organs, blood and skin are proteins - amino acid polymers that are joined by acid-based reactions. Your genetic makeup is found in the DNA (deoxyribonucleic acid) in the nuclei of your cells. Acid-based chemistry is literally all around you! There are two ways acids and bases can be described. One is one of their observable properties. The other is by describing their molecular structure and chemical reactivity. Let's make some observations first: Click on each attribute to see an example. WARNING: While acids and bases have characteristic tastes and feel, it is never safe to try or feel an unknown substance. Even if the examples given above are things safe to taste, many acids and bases will cause damage to your mouth and digestive system if injested and to your skin if touched. Page 4BRØNSTEDIn 1923, two chemists, Johannes N. Brønsted and Thomas M. Lowry, independently came up with a theory that would include non-aqueous acid-based chemistry. In this theory, an acid donates H+ ions (or protons) and a base accepts H+ ions (or protons). An acidic basic reaction can be described as proton transfer: Since Brønsted developed these ideas to a greater extent than Lowry, this is known as Brønsted theory, although some chemists refer to it as Brønsted-Lowry Theory.Page 5 A proton donor will give an H+ to another reactive while one proton acceptance will get an H+ from another reactive. According to Brenstead's theory, a proton donor is acid and a proton executor is a base. When the other reaction is water, acids and bases are easy to recognize: an acid will produce H3O+ while a base will produce OH-. Page 6 Write fixed ionization expressions for acids and bases Comparison of the potential of acids and bases using fixed ionization values Calculate the ionization constant of an acid or base from the pH of an aqueous concentration Calculate whether an acid-base solution will be a product or reactive solution favored by the power of an acid or base degree of ionization. A strong acid will completely ionize in water, while a weak acid will only partially ionize. Since there are different degrees there are different levels of weakness. Fortunately, there is a simple quantitative way of expressing this note. Given that the a weak acid is a balance, a chemical equation and a constant expression of balance can be written: The equilibrium constant for ionization of an acid is called the acid ionization constant (Ka). Fill in the following sentence: A stronger acid will be a better proton donor, forcing the balance to the right. This produces more hydron ions and a paired base. How will this affect ka? Good! A strong acid is a better proton donor, resulting in more products. Since the concentration of products is in the numerator of the expression Ka, the stronger the acid, the greater the Ka. A similar expression can be written for bases: The equilibrium constant for ionizing a base is called base ionization constant (Kb). Click on the strongest basis of the list below by comparing kb values. Page 7 Identify molecular properties that allow molecules and ions to act as acids and Lewis bases In a neutralization reaction, classify molecules and ions as acids or bases Lewis Brønsted theory defines acids and bases as proton and recipient donors. Around the same time that Johannes N. Brønsted and Thomas M. Lowry came up with their theory of acids and bases, Gilbert N. Lewis proposed his own theory. While the Brønsted-Lowry theory is based on proton transfer, Lewis's theory is based on electron transfer. A Lewis acid is a substance that can accept a pair of electrons to form a new bond. They are sometimes referred to as electrophiles, or seekers of an additional pair of electrons. A Lewis base is a substance that can donate a pair of electrons to form a new bond. Sometimes referred to as nucleophils, or seekers of a positive nucleus. Neutralization is the sharing of a pair of electrons between an acid and the base. The product formed in a neutralization reaction is sometimes called an adduct or complex. Page 8 Metal cations have two characteristics that allow them to act as Lewis acids: 1. Their positive load attracts electrons. 2. They have at least one empty orbital that can accommodate a pair of electrons. When a cation metal meets a substance with a solitary pair of electrons, a tuning joint can be formed. An example of this is when metal ions are in an aqueous solution they are hydrated (or form a coordination compound with water). The metal hyon is a Lewis acid; water is a Lewis base: There are many substances that have solitary pairs of electrons, making them possible Lewis bases when combined with metal cations. Some examples are presented below: One Lewis base that deserves special mention is hydroxide (OH-). The hydroxide ion is connected with many metal ions that form metallic hydroxide. Some metallic hydroxide is amphiprotic (or is able to act as an acid or base). Their amphiprotic nature allows the dissolution of solid metallic hydroxides when acid or base is added: Reaction as base: Zn(OH)2(-a) + 2 2 Zn2+(aq) + 4 H2O(l) Acid reaction: Zn(OH)2(s) + 2 OH-(aq) [Zn(OH)4]2-(aq) Which of the following molecules or ions can act as Lewis bases and bind to metal cations? (Hint: draw lewis structures for each molecule!) Good! Are there others? Good! Compounds or ions that have solitary pairs of electrons are usually able to act as Lewis bases and form assemblies with metal cations. Does CH4 have solitary pairs of electrons? Metal cations are possible Lewis acids. Page 9 There are molecular compounds (such as carbon dioxide and sulphur dioxide) that are able to neutralize basic oxides and hydroxides. These neutralization reactions cannot be described using either Arrhenius or Brønsted theories as they do not include protons. The chemical equation for the reaction of carbon dioxide by neutralizing the strong base calcium oxide is shown below: CaO(s) + CO2(g) CaCO3(s) The Lewis theory provides the best description for reactions like this. Carbon dioxide is a polar molecule whose positive center is in the carbon atom: This positive center is able to attract (and accept) the solitary electron pairs present in ion oxide (O2-). Thus, carbon dioxide acts as Lewis acid and ion oxide acts as Lewis base. In the following reaction, is BH3 acting as lewis acid or base? (Hint: Design Lewis structures for both reacting) (CH3)3N + BH3 (CH3)3N __ BH3 Lewis Acid Lewis Base Good! The Lewis structure of BH3 shows boron that has only three bonds and no solitary pairs of electrons that allow it to receive electrons from a donor. BH3 acts as Lewis acid, accepting a pair of electrons from (CH3)3N to form a bond. (CH3)3N has a solitary pair of electrons in nitrogen. Is this the characteristic of an acid or Lewis base? Page 10 Understand how a buffer resists changes in pH, even when acids and bases are added Select a paired acid-base pair that will make a buffer at a given pH Calculate the pH of a buffer Understand the buffer capacity Have you ever found a white residue in a pan after boiling water? Where does it come from? You may have been told this is because you have hard water. What exactly is hard water? Water is said to be hard when metal ions (specifically Ca2+ and Mg2+) dissolve in it. If calcium ions are present, CaCO3 will precipitate when the water is heated. This sediment accumulates not only in kitchenware, but also in pipes, which eventually clog the pipes. So, what do you do if you suspect you have hard water? Kits can be purchased that allow you to deal with the your home and measure its hardness. How exactly do these dependencies work? The basic idea behind these kits is rather simple. A few drops of a marker are added to a water sample. Then, a compound called EDTA (short for ethylene diaminetraacetic acid) is slowly added to the sample. EDTA forms complexes with calcium and magnesium ions that are red. Due to the of the pointer, when all metal ions have formed assemblies with EDTA, the solution will change the color from red to blue. If you know how much EDTA you have added and the elementometry of the chemical reaction, you can calculate how many metal ions were originally present in the water sample. For this analysis to work well, the water sample must be kept at a basic pH. Since both edta and the index are themselves weak acids, a buffer, which is able to maintain a fairly stable pH, even when acids and bases are added, is used. That may not sound simple at all. You may have many questions: How does the pointer cause the solution to change the color? What exactly is EDTA? Why should the water sample be kept at a basic pH? What is in the buffer that allows the addition of weak acids without affecting the pH? This section will answer these questions with the first description of each component of the water hardness test in more detail. Buffer solutions will be explored to a greater extent, including their pre-paratony and limitations. Page 11 A home test kit contains four elements. Each is described in detail below. Boat: This is simply a container that has been calibrated to keep the volume of water for which the test was designed. Ethylene ethylene tetraacetic acid (EDTA): EDTA forms complex ions with calcium and magnesium ions present in hard water. Use the following image to learn more about edta: Click on the circles in the figure below to learn more about EDTA. Clicking the mouse will restore the shape. The chemical reactions of EDTA and each metal ions are presented below: As EDTA is added to hard water, with which metal hyon will react first? Good! Since the reaction of calcium ions to EDTA has a greater equilibrium constant, it will be a more favored reaction. Remember that the greater the equilibrium constant, the more favored the reaction from the product. Index: The indicator for this reaction is Eriochrome Black T (structure shown on the right; click on the structure to see the three forms of the pointer). It's a weak polyprotic acid. The fully deproponed form is a red cluster with most metal ions, including Ca2+ and Mg2+. The indicator works as follows: Step 1: A small amount of index is added to the hard water sample and forms a cluster with some of the metal ions. Since the metal marker assemblies are red, the solution appears red. Step 2: EDTA is added to the solution and reacts with free metal ions (those not connected to the Since metal-EDTA bands are colourless, the solution still appears red. Step 3: EDTA continues to be added. Since all free metal ions are connected to EDTA, EDTA displaces the pointer, coincidenceing the remaining metal ions until all metal ions are connected to EDTA. The red metal cluster no longer exists and the pointer is free. The index is a weak weak and its color depends on how it is proton: Calculate what the following proportions would be in a solution with pH from 5: [HIn2-] to [H2In-], [In3-] to [HIn2-], [H2In-] to [HIn2-], and [HIn2-] to [In3-]. Click the color of an indicator solution on this pH in the color strip on the right. How do I calculate these proportions and how do they affect the color of the solution? Some of your calculated proportions are incorrect. Did you read the help available by clicking on the test tube above? After you enter your revised answer, click the solution color again to check your calculation. The correct answers have been entered for you. The next question is for the same type of calculation, so try to resolve the problem and see how these values are obtained before proceeding. The proportions you have calculated are correct, but you have not selected the solution color correctly. Which species is more pre-intensible in the solution? Is it so prevelent that its color will overcome the color of any other kind present (if you add 100 drops of blue food coloring to the water, adding two drops of yellow food color will not change the color of the water)? Good! Perform the same calculations at 7, 9 and 11 pH. Key: Correct answer incorrect answer, review your calculations above The correct answer has been entered for you. If your calculations are incorrect, clicking the solution color after re-entering your calculation will check your response again. Good! For this resolution to work, there must be a distinct color difference between the index-metal cluster (which is red) and the free indicator so that it is visible when EDTA has replaced the pointer and sympathized with all metal ions. As once specified, the free indicator will have a significant red color at pH below seven. When the pH reaches 11, the free indicator is significantly orange. A color change from red to orange can be difficult to detect visually. So the key to this analysis is to maintain a pH above seven and below eleven. Buffer solution: A buffer solution is a solution that resists changes in pH even when acids and bases are added. In this analysis, it has been found that the analysis will work best when the pH is between seven and eleven. One possibility would be to add a base (sodium hydroxide, NaOH for example) to the water sample until the desired pH is reached. Remember though that EDTA and the index are both weak acids. After adding these, it is possible that the pH of the solution will no longer be between seven and eleven. For the analysis to work, the pH of the solution must be range throughout the test. The buffer used in this test kit is able to maintain a pH close to 10 throughout the test. How does this buffer maintain a pH of 10 and will always do it? The rest. Rest. will investigate these two questions in detail. Page 12 The answer lies in the components of the buffer solution. The buffer solution is a mixture of ammonia (NH3) and ammonium (NH4+). Select the phrase that best complements the following statements: Good! Since ammonia (NH3) is a weak base, it will have a pH above 7 and since ammonium (NH4+) is a weak acid, it will have a pH below 7. Ammonia (NH3) is a weak base and ammonium (NH4+) is a weak acid. Ammonia (NH3) is the coupling base of ammonium (NH4+). Ammonium (NH4+) is the ammonia coupling acid (NH3). If a small amount of hydrochloric acid (HCl, a strong acid) is added to this buffer, what will it react to? Will an acid (such as HCl) be more likely to react with another acid (NH4+) or a base (NH3)? Since NH3 is a base, it will react with the added acid: NH3 + H + NH4+ Similarly, if a base (for example, sodium hydroxide, NaOH) is added, it will react with the acid to the buffer, NH4+: NH4 + + OH-NH3 + H2O This is how a buffer maintains an almost constant pH. Each buffer consists of a pair of acid bases. If an acid is added to the buffer, it is neutralized from the base. if a base is added to the buffer, it is neutralised by the acid. What is the pH of this buffer? The balance between ammonia (NH3) and ammonium (NH4+) can be described by the chemical equation: NH4+ + H2O NH3 + H3O+ NOTE: The balance between NH3 and NH4+ can also be described with the chemical equation: NH3 + H2O NH4++ OH- It is easier to use the first equation as we try to calculate the pH (a measurement of H3O+ concentration). The buffer solution is made by dissolving 2,7 g of ammonium chloride (NH4Cl) in concentrated ammonia of 17,8 mL (NH3, 16 M) and diluting to 100 mL with distilled water. What are the concentrations of NH4+and NH3 in this solution? (You can ignore any proton transfers.) transport.)