Conjugate acid base pairs chem worksheet 19-2

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Once you find your sheet, click on the pop-up icon or print icon on the print or download sheet. The sheet will open in a new window. You can download or print using browser document readers. Acid-base vapors, the strength of acids and bases, as well as pH conjugated acid-base acid pairs and bases exist as conjugated acid-base pairs. The term conjugation comes from Latin stems, meaning connected together and refers to things that are connected, especially in pairs such as Brnstead acids and bases. Every time Brnstead's acid acts as a donor to the XK-ion, it forms a conjugation base. Imagine a generic acid, HA. When this acid donates ion NZ into the water, one of the results of the reaction is Ion A, which is a hydrogen-ion taker, or Brnstead base. HA and H2O H3O - acid base, on the contrary, every time the base acquires ion NH, the product Brnsted Acid, HA. Thus, A- H2O HA - OH- base acidic acids and bases in the Brnsted model exist as conjuged pairs whose formulas are associated with winning or losing loss Ion. Our use of HA and A- symbols for conjugation acid-base vapor does not mean that all acids are neutral molecules or that all bases are negative ion. This only means that the acid contains ion NH, which is not present in conjugated bases. Brnstead acids or bases can be neutral molecules, positive ion or negative ion. The various acids are Brnsted and their conjuged bases are shown in the table below. Typical Brnsted acids and their conjugated acid base base H3O' H2O H2O H2O- OH-O2- HCl- H2SO4 HSO4- HSO4- SO42- NH4 NH3 NH3 NH2- Compound can be both Brnstead acid and Brnsted base. H2O, OH-, HSO4- and NH3, for example, can be found in both columns in the table above. Water is a great example of this behavior because it simultaneously acts as an acid and base when it forms H3O and OH ions. Strong and weak acids and bases Many hardware stores sell muriatic acid 6 M solution of HCl (aq) sylated acid to clean bricks and concrete. Grocery stores sell vinegar, which is a 1 M solution of acetic acid: CH3CO2H. While both substances are acid, you wouldn't use suriatic acid in salad dressing, and vinegar is ineffective in cleaning bricks or concrete. The difference between them is that suriatic acid is a strong acid and vinegar is a weak acid. Muriatic acid is strong because it is very good at transferring Ion H e into a water molecule. In solution 6 M of syll acid 99.996% of HCl molecules react with water to form H3O and Cl- ions. HCl (aq) - H2O (l) H3O (aq) - Cl- (aq) Vinegar is a weak acid because it does not tolerate H' ions very well in the water. In solution 1 M, less than 0.4% of CH3CO2H molecules react with water, forming H3O and CH3CO2 ions. CH3CO2H (aq) - H2O (l) H3O (aq) - CH3CO2- (aq) More than 99.6% of acetic acid molecules remain intact. Acid Dissociation Balance Constant, Ka Relative Strengths of Acids is often described in terms of acid-dissociation of the constant equilibrium, Ka. To understand the nature of this constant equilibrium, let's assume that the reaction between acid and water can be represented by the following general equation. HA (aq) - H2O (l) H3O (aq) - A- (aq) In other words, some HA molecules react to the formation of H3O and A- ions, as shown in the picture below. According to the convention, the concentrations of these ions in mole units per liter are represented by the symbols H3O and A-. The concentration of HA molecules that remain in the solution is represented by the HA symbol. The value of Ka for acid is calculated from the next equation. When a strong acid dissolves in water, the acid reacts actively with water to form H3O and ions. (Only a small residual concentration of HA molecules remains in the solution.) Thus, the product of the concentrations of H3O and A- than the concentration of HA molecules, so Ka for strong acid is more than 1. Example: Hydrochloric acid has about 1 x 106. Weak acids, on the other hand, react only slightly with water. Thus, the concentration of concentrations of H3O and A- Ions is less than the concentration of residual HA molecules. As a result, Ka for weak acid is less than 1. Example: Acetic acid has Ka only 1.8 x 10-5. Therefore, Ka can be used to distinguish between strong acids and weak acids. Strong Acids: 1 Weak Acids: Ka'lt; 1 The Relative Strengths of Conjugated Acid Vapors Strong Acids have a weak conjugation base. Example: HCl is a strong acid. If HCl is a strong acid, it should be a good proton donor. HCl can only be a good proton donor, however, if cl-ion is a bad proton reception. Thus, Cl-ion should be a weak base. HCl (g) - H2O (l) H3O (aq) - Cl- (aq) Strong acid Weak base Strong bases have weak conjugation acid. Example: Consider the relationship between ammonium strength (NH4) and its conjugation base, ammonia (NH3). NH4 ion is a weak acid because ammonia is a fairly good base. NH4 (aq) - H2O (l) H3O (aq) - NH3 (aq) Weak Acid Good Basic Practice Problem 3: Use acid-dissociation of equilibrium constants for conjuged acids of these bases to predict whether CH3CO2- ion or OH - ion is a stronger base. CH3CO2H: Ka 1.8 x 10-5 H2O: Ka 1.8 x 10-16 Click here to test your response to The Problem 3 Comparison of relative strong acid pairs and bases The value of Ka for acid can be used to decide whether it is a strong acid or a weak acid, in an absolute sense. It can also be used l to compare the relative strengths of a pair of acids. Example: Consider HCl and H3O ion. HCl Ka 1 x 106 H3O Ka 55 These values suggest that both are strong acids, but HCl is a stronger acid than H3O ion. The high proportion of HCl molecules in the aquiskin reacts with water to form H3O and Cl- ions. Brnstead's theory suggests that each acid-base reaction converts acid into a conjugable base and base into conjugable acid. There are two acids and two basics in this reaction. Stronger acid, however, is on the left side of the equation. HCl (g) - H2O (l) H3O (aq) - Cl- (aq) stronger acid weaker acid Common rules suggest that the stronger the vapor of acids, the weaker the pair of conjuged bases. The fact that HCl is a stronger acid than H3O ion means that Cl-ion is a weaker base than water. Acid Force: HCl's base strength H3O: Cl- h2O Thus, the reaction equation between HCl and water can be written as follows. HCl (g) - H2O (l) H3O (aq) - Cl- (aq) stronger acid base weaker acid weaker base It's not surprising that 99.996% 99.996% HCl molecules in a 6 M solution react with water to give ions H3O and Cl- ions. The stronger the acid vapor, the stronger the base vapor to form a weaker acid and a weaker base. Let's look at the relative strengths of acetic acid and H3O ion. CH3CO2H Ka 1.8 x 10-5 H3O Ka 55 Values Ka for these acids suggest that acetic acid is a much weaker acid than H3O ion, which explains why acetic acid is a weak acid in water. Once again, the reaction between acid and water should convert the acid into its conjugable base and base into its conjugable acid. But this time, stronger acid and a stronger base are on the right side of the equation. CH3CO2H (aq) - H2O (l) H3O (aq) - CH3CO2- (aq) weaker acid base is stronger than the base As a result, few of the CH3CO2H molecules actually donate Ion H E to the water molecule to form H3O and CH3CO2- ions. The ca size can also be used to explain why some compounds that qualify as brnsted acids or bases do not act as acids or bases when they dissolve in water. When the value of Ka for acid is relatively large, the acid reacts with water until essentially all the acid molecules have been destroyed. Sulphuric acid (Ka No. 1 x 103), for example, reacts with water until 99.9% of H2SO4 molecules in 1 M solution have lost a proton to form HSO4-ions. H2SO4 (aq) - H2O (l) H3O (aq) - HSO4-(aq) As the acid response to water decreases. As long as Ka for acid is significantly greater than ka's value for water, the acid will ionize to some extent. Acetic acid, for example, reacts to some extent with water to form H3O and CH3CO2-, or acetate, ions. CH3CO2H (aq) - H2O (l) H3O (aq) - CH3CO2-(aq) As the value of Ka for acid approaches Ka for water, the compound becomes more like water in its acidity. Although it is still a brnsted acid, it is so weak that we may not be able to detect this acidity in an aqueous solution. Some potential acids are so weak that their Ka values are smaller than water. Ammonia, for example, has Ka only 1 x 10-33. Although NH3 may be a brnstead acid because it has the potential to act as a donor to hydrogen ions, there is no evidence of this acidity when it dissolves in water. The effect of water alignment All strong acids and bases seem to have the same force when dissolved in water, regardless of the value of Ka. This phenomenon is known as the water-leveling tendency of water to limit the strength of strong acids and bases. We can explain this by the fact that strong acids actively react with water to form H3O ion. More than 99% of HCl molecules in the cell acid react with water to H3O and Cl- ions, such as HCl (g) h2O (l) H3O (aq) and more than 99% of H2SO4 molecules in 1 M M solution with water to form Ions H3O and HSO4-ions. H2SO4 (aq) - H2O (l) H3O (aq) - HSO4-(aq) Thus, the force of strong acids is limited by the force of acid (H3O) formed when water molecules pick up ion H. A similar phenomenon occurs in the decisions of strong bases. Strong bases react quantitatively with water to form an OH-ion. Once this happens, the solution could not become more basic. The strength of the strong bases is limited by the strength of the base (OH-), formed when water molecules lose ion NH. The benefits of a brnsted definition of Brnsted definition of acids and bases offers many advantages over Arrhenius and operational definitions. It expands the list of potential acids to include positive and negative ions as well as neutral molecules. It expands the base list to include any molecule or ion with at least one pair of non-binding valence electrons. This explains the role of water in acid-based reactions: Water takes H'e ions from acids to form H3O ion. It can be extended to include solvents other than water and reactions that occur in gas or solid phases. It binds acids and bases into conjugated acid-base vapors. It may explain the link between the strengths of acid and its conjuged base. This may explain the differences in the relative strengths of a pair of acids or a pair of bases. This may explain the effect of water alignment by the fact that the strong acids and bases all have the same effect when dissolved in water. Because of these benefits, whenever chemists use the word acid or base without any further description, they mean a brnsted acid or brnsted base. as a measure of the concentration of Ionov pure water H3O' is both a weak acid and a weak base. The water itself forms only a very small amount of H3O and OH Ions, which characterize water solutions of stronger acids and bases. H2O (l) - H2O (l) H3O (aq) - OH- (aq) the base acidic base of H3O concentrations and OH-ions in water can be determined by carefully measuring the water's ability to conduct electric current. At 25oC, the concentration of these ions in clean water is 1.0 x 10-7 moles per liter. When we add strong acid to the water, the concentration of H3O ion increases. HCl (aq) - H2O (l) H3O (aq) - Cl- (aq) At the same time, the concentration of OH-ions decreases because the H3O ions produced in this reaction neutralize some OH- ions in the water. H3O (aq) - OH- (aq) 2 H2O (l) The product of H3O and OH-ions concentrations is permanent, no matter how much acid or base is added to the water. In clean water at 25oC, the product concentration of these ions is 1.0 x 10-14. (H3O) The range of concentrations of H3O and OH Ionov in an aquirat solution is so large that it is difficult to work with. In 1909, the Danish With.. L. Sorenson suggested reporting H3O ion concentrations on a logarithic scale, which he called a pH scale. Since the concentration of H3O ions in water is almost always less than 1, the log of these concentrations is a negative number. To avoid having to constantly work with negative numbers, Sorenson defined pH as a negative in the H3O ion ion journal. pH and H3O magazine The pH concept compresses the range of H3O ions concentrations into a scale that is much easier to handle. As the concentration of H3O' ions decreases from about 100 to 10-14 pH, the solution increases from 0 to 14. If the concentration of H3O ion in clean water at 25oC is 1.0 x 10-7 M, the pH of pure water is 7. pH - Journal (H3O) - Journal (1.0 x 10-7) - 7 When the pH solution is less than 7, the solution is sour. When the pH is more than 7, the solution is basic. Acid: pH qlt; 7 Basic: pH zgt; 7 pH common acids and the base of pH solution depends on the strength of the acid or base in the solution. Therefore, measurements of the pH of dilution solutions are good indicators of the relative strength of acids and bases. PH values of 0.10 M of solutions of a number of common acids and bases are shown in the table below. PH 0.10 M Solutions of Common Acids and Bases of PH HCl (sylaic acid) 1.1 H2SO4 (sulphuric acid) 1.2 NaHSO4 (sodium hydrogen sodium) 1.4 H2SO3 (sulphuric acid) 1.5 H3PO4 (phosphoric acid) 1.5 HF (hydroph) 2.1 CH3CO2H (acetic acid) 2.9 H2CO3 (carbon acid) 3.8 (saturated solution) H2S (hydrogen sulfide) 4.1 NaH2PO4 (sodium dihydrogen phosphate) 4.4 NH4Cl (ammonium chloride) 4.. 6 HCN (hydrocyanic acid) 5.1 Na2SO4 (sodium sulfate) 6.1 NaCl (sodium chloride) 6.4 NaCH3CO2 (sodium acetate) 8.4 NaHCO3 (sodium bicarbonate) 8.4 Na2HPO4 (sodium hydrogen phosphate) 9.3 Na2SO3 (sodium sulfite) 9.8 NaCN (sodium cyanide) 11.0 NH3 (aqueous ammonia) 11.1 Na2CO3 (sodium carbonate) 11.6 Na3PO4 (sodium phosphate) 12.0 NaOH (sodium hydroxide, sodium hydroxide, sodium, lye) 13.0 13.0 conjugate acid base pairs chem worksheet 19-2 answer key