Acids vs. Bases

Definitions

Acid: donates proton (H^+)

Examples: HCl, HNO_3, NH_4^+, $H_2PO_4^-$

Base: receives proton (H^+)

Examples: NH_3, CO_3^{2-}

Amphiprotic: can behave either as acid or base

Examples: H_2O, $H_2PO_4^-$

Conjugate acid-base pair: two species that differ by one H^+

Formulas

$pH = -\log [H^+]$

$[H^+] = 10^{-pH}$

$pOH = -\log [OH^-]$

$[OH^-] = 10^{-pOH}$

$pH + pOH = 14$

$Kw = 1.0 \times 10^{-14}$ at 25°C

$Kw = Ka \times Kb$

$Kw = [H^+] [OH^-]$

$pKw = -\log (Kw) = -\log (1.0 \times 10^{-14}) = 14$

$pKa = -\log (Ka)$

$pKb = -\log (Kb)$

Ka and Kb expressions = [products] / [reactants] (remember to exclude solids and liquids, like water)

Comparing Relative Strengths of Acids and Bases

The stronger the acid, the larger its Ka value, thus the smaller its pKa value

Stronger acids will have weaker conjugate bases with small Kb values

The stronger the base, the larger its Kb value, thus the smaller its pKb value

Stronger bases will have weaker conjugate acids with small Ka values

	pH	$[H^+]$	$[OH^-]$	pOH
Basic	14.00	1.0×10^{-14}		
			1.0×10^{-4}	
Neutral	7.00			
Acidic		1.0×10^{-4}	1.0×10^{-10}	
				14.00

Acid Base HOMEWORK

1. In the following reaction, identify the acid on the left and its conjugate base on the right. Identify the base on the left and its conjugate acid on the right.

   $HBr + NH_3 \rightarrow NH_4^+ + Br^-$

2. What is the conjugate base of H_2S?
3. What is the conjugate acid of NO_3^-?
4. Write the simple dissociation (ionization) reaction for each of the following acids.
   a. Hydrochloric acid (HCl)
   b. Acetic acid ($HC_2H_3O_2$)
   c. Ammonium ion (NH_4^+)
5. Using the Kb values from the appendix of your textbook, arrange the following species according to their strength as bases:
   a. H_2O, F^-, Cl^-, NO_2^-, and CN^-
6. Calculate either the $[H^+]$ or $[OH^-]$ from the information given for each of the following solutions at 25°C, and state whether the solution is neutral, acidic, or basic.
   a. 1.0×10^{-5} M OH^-
   b. 1.0×10^{-7} M OH^-
   c. 10.0 M H^+
7. Calculate pH and pOH for each of the following solutions at 25°C.
   a. 1.0×10^{-3} M OH^-
   b. 1.0 M H^+
8. The pH of a sample of human blood was measured to be 7.41 at 25°C. Calculate pOH, $[H^+]$, and $[OH^-]$ for the sample.
9. Calculate the pH of each solution.
   a. 0.10 M HNO_3 solution
   b. 1.0×10^{-10} M HCl solution
   c. 5.0×10^{-2} M NaOH solution
10. The hypochlorite ion (OCl^-) is a strong oxidizing agent often found in household bleaches and disinfectants. It is also the active ingredient that forms when swimming pool water is treated with chlorine. In addition to its oxidizing abilities, the hypochlorite ion has a relatively high affinity for protons (it is a much stronger base than Cl^-, for example) and forms the weakly acidic hypochlorous acid (HOCl, Ka = 3.5×10^{-8}). Calculate the pH of a 0.100 M aqueous solution of hypochlorous acid.
11. Calculate the pH for a 15.0 M solution of NH_3 (Kb = 1.8×10^{-5}).
12. Calculate the pH of a 1.0 M solution of methylamine (Kb = 4.38×10^{-4}).
13. Calculate the percent dissociation of acetic acid (Ka = 1.8×10^{-5}) in each of the following solutions.
    a. 1.00 M $HC_2H_3O_2$
    b. 0.100 M $HC_2H_3O_2$
14. Lactic acid ($HC_3H_5O_3$) is a waste product that accumulates in muscle tissue during exercise, leading to pain and a feeling of fatigue. In a 0.100 M aqueous solution, lactic acid is 3.7% dissociated. Calculate the value of Ka for this acid.