

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

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

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

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

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

$$pH + pOH = 14$$

$$K_w = 1.0 \times 10^{-14} \text{ at } 25^\circ\text{C}$$

$$K_w = K_a \times K_b$$

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

$$pK_w = -\log (K_w) = -\log (1.0 \times 10^{-14}) = 14$$

$$pK_a = -\log (K_a)$$

$$pK_b = -\log (K_b)$$

K_a and K_b expressions = $\frac{[\text{products}]}{[\text{reactants}]}$
(remember to exclude solids and liquids, like water)

Comparing Relative Strengths of Acids and Bases

The stronger the acid, the larger its K_a value, thus the smaller its pK_a value

Stronger acids will have weaker conjugate bases with small K_b values

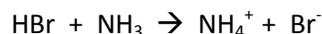
The stronger the base, the larger its K_b value, thus the smaller its pK_b value

Stronger bases will have weaker conjugate acids with small K_a 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.



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 ($\text{HC}_2\text{H}_3\text{O}_2$)
 - c. Ammonium ion (NH_4^+)
5. Using the K_b 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 $[\text{H}^+]$ or $[\text{OH}^-]$ from the information given for each of the following solutions at 25°C , and state whether the solution is neutral, acidic, or basic.
 - a. $1.0 \times 10^{-5} \text{ M OH}^-$
 - b. $1.0 \times 10^{-7} \text{ M OH}^-$
 - c. 10.0 M H^+
7. Calculate pH and pOH for each of the following solutions at 25°C .
 - a. $1.0 \times 10^{-3} \text{ M OH}^-$
 - 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, $[\text{H}^+]$, and $[\text{OH}^-]$ for the sample.
9. Calculate the pH of each solution.
 - a. 0.10 M HNO_3 solution
 - b. $1.0 \times 10^{-10} \text{ M HCl}$ solution
 - c. $5.0 \times 10^{-2} \text{ M NaOH}$ 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 , $K_a = 3.5 \times 10^{-8}$). 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 ($K_b = 1.8 \times 10^{-5}$).
12. Calculate the pH of a 1.0 M solution of methylamine ($K_b = 4.38 \times 10^{-4}$).
13. Calculate the percent dissociation of acetic acid ($K_a = 1.8 \times 10^{-5}$) in each of the following solutions.
 - a. $1.00 \text{ M HC}_2\text{H}_3\text{O}_2$
 - b. $0.100 \text{ M HC}_2\text{H}_3\text{O}_2$
14. Lactic acid ($\text{HC}_3\text{H}_5\text{O}_3$) 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 K_a for this acid.