

Recitation Section Problems

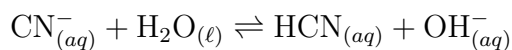
February 12, 2018

Solutions

1. The pK_a of hydrocyanic acid, HCN, is 9.21. Calculate the pH of an aqueous 0.123 M NaCN solution.

Answer:

$$K_a = 10^{-9.21} = 6.2 \times 10^{-10}$$



$$K_b = \frac{[\text{HCN}][\text{OH}^-]}{[\text{CN}^-]} = \frac{1.0 \times 10^{-14}}{6.2 \times 10^{-10}} = 1.6 \times 10^{-5}$$

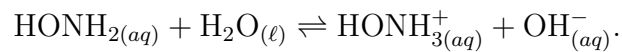
	$[\text{CN}^-]$	$[\text{HCN}]$	$[\text{OH}^-]$
initial	0.123 M	0 M	0 M
change	$-y$	y	y
equilibrium	$(0.123 - y)$ M	y M	y M

$$\frac{y^2}{0.123 - y} \approx \frac{y^2}{0.123} = 1.6 \times 10^{-5}$$

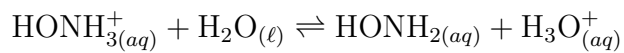
$$y = [\text{OH}^-] = 1.4 \times 10^{-3} \text{ M}$$

$$\text{pOH} = -\log_{10}(1.4 \times 10^{-3}) = 2.85 \quad \text{pH} = 14.00 - 2.85 = 11.15$$

2. The pH of a 2.500 M aqueous hydroxylammonium chloride solution (HONH_3Cl) is 2.78. Calculate K_b for the reaction



Answer:



$$[\text{H}_3\text{O}^+] = 10^{-2.78} = 1.7 \times 10^{-3} \text{ M} = [\text{HONH}_2]$$

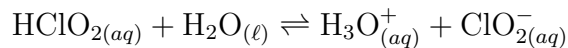
$$[\text{HONH}_3^+] = 2.500 \text{ M} - 1.7 \times 10^{-3} \text{ M} = 2.498 \text{ M}$$

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{HONH}_2]}{[\text{HONH}_3^+]} = \frac{(1.7 \times 10^{-3})^2}{2.498} = 1.2 \times 10^{-6}$$

$$K_b = \frac{1.0 \times 10^{-14}}{1.2 \times 10^{-6}} = 8.6 \times 10^{-9}$$

3. The pK_a of chlorous acid (HClO_2) is 1.96. A solution is made that is 1.20 M in chlorous acid and 0.50 M in sodium chlorite (NaClO_2). Calculate the pH of the resulting solution. You must solve the full quadratic equation for this system.

Answer:



$$K_a = \frac{[\text{ClO}_2^-][\text{H}_3\text{O}^+]}{[\text{HClO}_2]} = 10^{-1.96} = 1.1 \times 10^{-2}$$

	$[\text{HClO}_2]$	$[\text{ClO}_2^-]$	$[\text{H}_3\text{O}^+]$
initial	1.20 M	0.50 M	0 M
change	$-y$	y	y
equilibrium	$(1.20 - y)$ M	$(0.50 + y)$ M	y M

$$\frac{y(y + 0.50)}{1.20 - y} = 1.1 \times 10^{-2}$$

$$y^2 + 0.51y - 0.013 = 0$$

$$y = \frac{-0.51 \pm [(0.51)^2 + 4(0.013)]^{1/2}}{2} = 2.5 \times 10^{-2} \quad \text{negative solution ignored}$$

$$[\text{H}_3\text{O}^+] = 2.5 \times 10^{-2} \text{ M} \quad \text{pH} = -\log_{10}(2.5 \times 10^{-2}) = 1.61$$