

AP CHEMISTRY

TOPIC 7: ACIDS & BASES, MORE EXAMPLES

Day 83:

CLEARLY SHOW THE METHOD USED AND THE STEPS INVOLVED IN ARRIVING AT YOUR ANSWERS.



1. Hexanoic acid, $\text{HC}_6\text{H}_{11}\text{O}_2(\text{aq})$, is a monoprotic acid that dissociates in an aqueous solution, as represented by the equation above. The equilibrium concentration for the hexanoate ions, $\text{C}_6\text{H}_{11}\text{O}_2^{-1}(\text{aq})$, is equal to 0.00332 M . Hexanoic acid's initial concentration is $0.750\text{ M HC}_6\text{H}_{11}\text{O}_2(\text{aq})$ at 298 K . For parts (a) through (d) below, assume the temperature remains at 298 K .

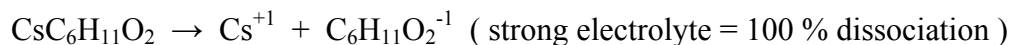
- (a) Write the expression for the acid-dissociation constant, K_a , for hexanoic acid and calculate its value.

$$K_a = \frac{[\text{H}^+][\text{C}_6\text{H}_{11}\text{O}_2^{-1}]}{[\text{HC}_6\text{H}_{11}\text{O}_2]} = \frac{(0.00332)^2}{(0.75 - 0.00332)} = 1.48 \times 10^{-5}$$

- (b) Calculate the pH of the above solution at equilibrium.

$$[\text{H}^+] = 0.00332, \quad \text{pH} = -\log(0.0032) = 2.48$$

- (c) Calculate the pH of a solution formed by dissolving 21.7 grams of solid cesium hexanoate, $\text{CsC}_6\text{H}_{11}\text{O}_2$, in 250 mL of $0.75\text{ M HC}_6\text{H}_{11}\text{O}_2(\text{aq})$. Assume that volume change is negligible. (This time we will write the ICE chart in a way that expresses the addition of the solid, and cause the reaction to shift to the left)



$$\frac{21.7\text{ g}}{247.9969\text{ g}} \times \frac{1\text{ mol CsC}_6\text{H}_{11}\text{O}_2}{1} = 0.0875\text{ mol} ; \quad \frac{0.0875\text{ mol}}{0.250\text{ L}} = 0.35\text{ M} = [\text{Cs}^+] = [\text{C}_6\text{H}_{11}\text{O}_2^{-1}]$$

	$[\text{C}_6\text{H}_{11}\text{O}_2^{-1}]$	+	HOH	\rightleftharpoons	$[\text{HC}_6\text{H}_{11}\text{O}_2]$	+	$[\text{OH}^{-1}]$
I	0.35 M		-		0.75		~ 0
C	$-x$		-		$+x$		$+x$
E	$0.35 - x$		-		$0.75 + x$		$[\text{OH}^{-1}]$

$$K_b = \frac{K_w}{K_a} = \frac{1.00 \times 10^{-14}}{1.48 \times 10^{-5}} = 6.76 \times 10^{-10}$$

$$K_b = \frac{[\text{HC}_6\text{H}_{11}\text{O}_2][\text{OH}^{-1}]}{[\text{C}_6\text{H}_{11}\text{O}_2^{-1}]} = \frac{(0.750 + x)[\text{OH}^{-1}]}{(0.35 - x)} = \frac{(0.750)[\text{OH}^{-1}]}{(0.35)} = 1.48 \times 10^{-5}$$

$$[\text{OH}^{-1}] = \frac{(6.76 \times 10^{-10})(0.35)}{(0.750)} = 3.15 \times 10^{-10}$$

$$\text{pH} = 14 - \text{pOH}, \quad \text{pH} = 14 - (-\log(3.15 \times 10^{-10})) = 4.50$$