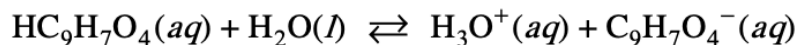


**AP<sup>®</sup> CHEMISTRY**  
**2015 SCORING GUIDELINES**

**Question 7**



The molecular formula of acetylsalicylic acid, also known as aspirin, is  $\text{HC}_9\text{H}_7\text{O}_4$ . The dissociation of  $\text{HC}_9\text{H}_7\text{O}_4(aq)$  is represented by the equation above. The pH of  $0.0100\text{ M HC}_9\text{H}_7\text{O}_4(aq)$  is measured to be 2.78.

- (a) Write the expression for the equilibrium constant,  $K_a$ , for the reaction above.

$K_a = \frac{[\text{H}_3\text{O}^+][\text{C}_9\text{H}_7\text{O}_4^-]}{[\text{HC}_9\text{H}_7\text{O}_4]}$	1 point is earned for the correct expression.
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- (b) Calculate the value of  $K_a$  for acetylsalicylic acid.

$[\text{H}_3\text{O}^+] = 10^{-\text{pH}} = 10^{-2.78} = 1.66 \times 10^{-3}\text{ M}$ $[\text{H}_3\text{O}^+] = [\text{C}_9\text{H}_7\text{O}_4^-] = 1.66 \times 10^{-3}\text{ M}$ $[\text{HC}_9\text{H}_7\text{O}_4] = 0.0100\text{ M} - 1.66 \times 10^{-3}\text{ M}$ $K_a = \frac{(1.66 \times 10^{-3})^2}{0.0100 - (1.66 \times 10^{-3})} = 3.3 \times 10^{-4}$	1 point is earned for the correct $[\text{H}_3\text{O}^+]$ .  1 point is earned for the value of $K_a$ .
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- (c) An aqueous solution of aspirin is buffered to have equal concentrations of  $\text{HC}_9\text{H}_7\text{O}_4(aq)$  and  $\text{C}_9\text{H}_7\text{O}_4^-(aq)$ . Calculate the pH of the solution.

$\text{pH} = \text{p}K_a + \log \frac{[\text{C}_9\text{H}_7\text{O}_4^-]}{[\text{HC}_9\text{H}_7\text{O}_4]}$ $= -\log(3.3 \times 10^{-4}) + 0$ $= 3.48$	1 point is earned for a pH consistent with the $K_a$ calculated in part (b).
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