AP® CHEMISTRY
2015 SCORING GUIDELINES

Question 7

$$HC_9H_7O_4(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + C_9H_7O_4^-(aq)$$

The molecular formula of acetylsalicylic acid, also known as aspirin, is $HC_9H_7O_4$. The dissociation of $HC_9H_7O_4(aq)$ is represented by the equation above. The pH of 0.0100 M $HC_9H_7O_4(aq)$ is measured to be 2.78.

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

$K_a = \dfrac{[H_3O^+][C_9H_7O_4^-]}{[HC_9H_7O_4]}$	1 point is earned for the correct expression.

(b) Calculate the value of K_a for acetylsalicylic acid.

$[H_3O^+] = 10^{-pH} = 10^{-2.78} = 1.66 \times 10^{-3}\ M$ $[H_3O^+] = [C_9H_7O_4^-] = 1.66 \times 10^{-3}\ M$ $[HC_9H_7O_4] = 0.0100\ M - 1.66 \times 10^{-3}\ M$ $K_a = \dfrac{(1.66 \times 10^{-3})^2}{0.0100 - (1.66 \times 10^{-3})} = 3.3 \times 10^{-4}$	1 point is earned for the correct $[H_3O^+]$. 1 point is earned for the value of K_a.

(c) An aqueous solution of aspirin is buffered to have equal concentrations of $HC_9H_7O_4(aq)$ and $C_9H_7O_4^-(aq)$. Calculate the pH of the solution.

$pH = pK_a + \log \dfrac{[C_9H_7O_4^-]}{[HC_9H_7O_4]}$ $= -\log(3.3 \times 10^{-4}) + 0$ $= 3.48$	1 point is earned for a pH consistent with the K_a calculated in part (b).