$4 < pK_a < 5$

Free Response Practice

1. A chemist creates a buffer at pH 4.30 by combining one of the acids from the following list and their soluble salt in a solution.

		pK_a
• chloroacetic acid, $HC_2H_2ClO_2$	$K_a = 1.35 \times 10^{-3}$	
• propanoic acid, $HC_3H_5O_2$	$K_a = 7.3 \times 10^{-5}$	4.13
• benzoic acid, $HC_6H_5CO_2$	$K_a = 6.4 \times 10^{-5}$	4.19
• hypochlorous acid, HClO	$K_a = 3.5 \times 10^{-8}$	

a. Which weak acid would work best? Justify your choice with calculations.

b. Identify an appropriate salt that can be used with the weak acid chosen above to complete the buffer system.

c. Write an equilibrium reaction to describe this buffer.

d. What would be true about the weak acid/conjugate base ratio ($\frac{HA}{A^-}$) in your buffer system if the acid chosen above was used to prepare the desired buffer at pH 4.30? Justify your answer.

e. How would adding HBr to the buffer system change the weak acid/conjugate base ratio ($\frac{HA}{A^-}$) identified in part (d)? Explain.

f. How could you prepare a buffer solution from the weak acid chosen in part (a) if you were NOT provided with the conjugate salt, but instead solutions of a strong acid and a strong base?

(a.) Benzoic acid, b/c when $[HC_6H_5CO_2] = [C_6H_5CO_2^-]$, the pH of the buffer sol'n created would be 4.19, closer to the desired pH of 4.30 than the other options.

(b.) $NaC_6H_5CO_2$

(c.) $HC_6H_5CO_{2(aq)} + H_2O_{(l)} \rightleftharpoons C_6H_5CO_2^-{}_{(aq)} + H_3O^+_{(aq)}$

(d.) Since the desired pH of $4.30 > 4.19$, the pK_a of the weak acid (and thus the pH of sol'n if $[HC_6H_5CO_2] = [C_6H_5CO_2^-]$), $\frac{HA}{A^-} < 1$, since the sol'n is more basic than @ $pH = pK_a$, so $[A^-] > [HA]$.

(e.) Adding HBr is adding H^+ ions, which will convert the conjugate base (A^-) into weak acid (HA), ↑ [HA] and ↓ $[A^-]$. This would increase the HA/A^- ratio, possibly to 1 or > 1 depending on how much HBr was added.

(f.) Add strong base to the weak acid until # mol SB = ½ # mol WA (ignore the strong acid → not helpful)