

Basic Competency Quiz #5
 Chemistry, 7th ed., Zumdahl & Zumdahl, sections 15.2-15.4

Unless otherwise specified, each question is worth 5 points.

1. A solution contains both 0.40 M benzoic acid, HOOC_6H_5 ($K_a=6.5 \times 10^{-5}$) and 0.40 M sodium benzoate, NaOOC_6H_5 . Calculate the pH of this solution.

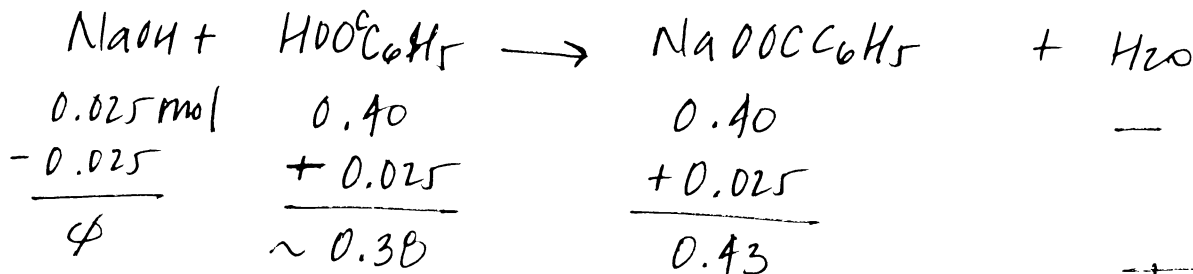
IT'S A BUFFER!

$$\text{p}K_a = -\log(6.5 \times 10^{-5})$$

$$= 4.19$$

$$\text{pH} = \text{p}K_a + \log \frac{[\text{BASE}]}{[\text{ACID}]} = 4.19 + \log \left(\frac{0.40}{0.40} \right) = \boxed{4.19}$$

2. 0.025 moles of NaOH is added to 1.0 L of the solution described in problem #1. (Disregard any change in volume.)
 a. Calculate the change in pH that occurs when. (3 points)



$$\text{pH} = \text{p}K_a + \log \frac{[\text{BASE}]}{[\text{ACID}]} = 4.19 + \log \frac{0.43}{0.38} = 4.19 + 0.05 = \boxed{4.24}$$

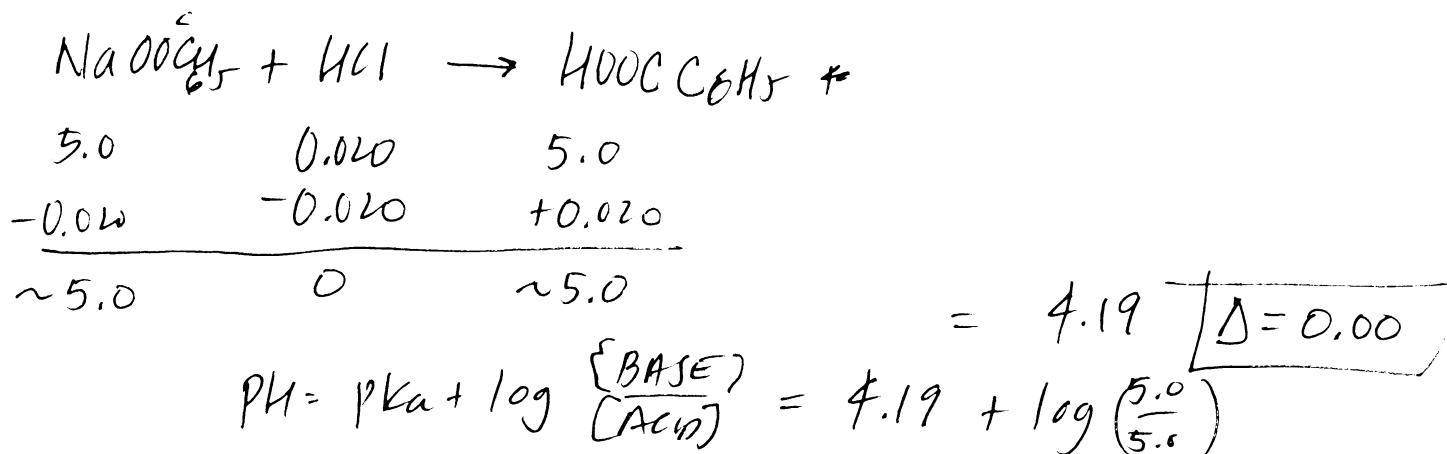
- b. 1.0 L of pure water that contains 0.025 mol NaOH has a pH of about 12.40. Briefly – in about 1 sentence – explain why the pH did change to about 12 after adding the NaOH to the solution. (2 points)

IT'S A BUFFER; BUFFERS RESIST CHANGES
 IN PH DESPITE THE ADDITION OF STRONG
 ACID OR BASE.

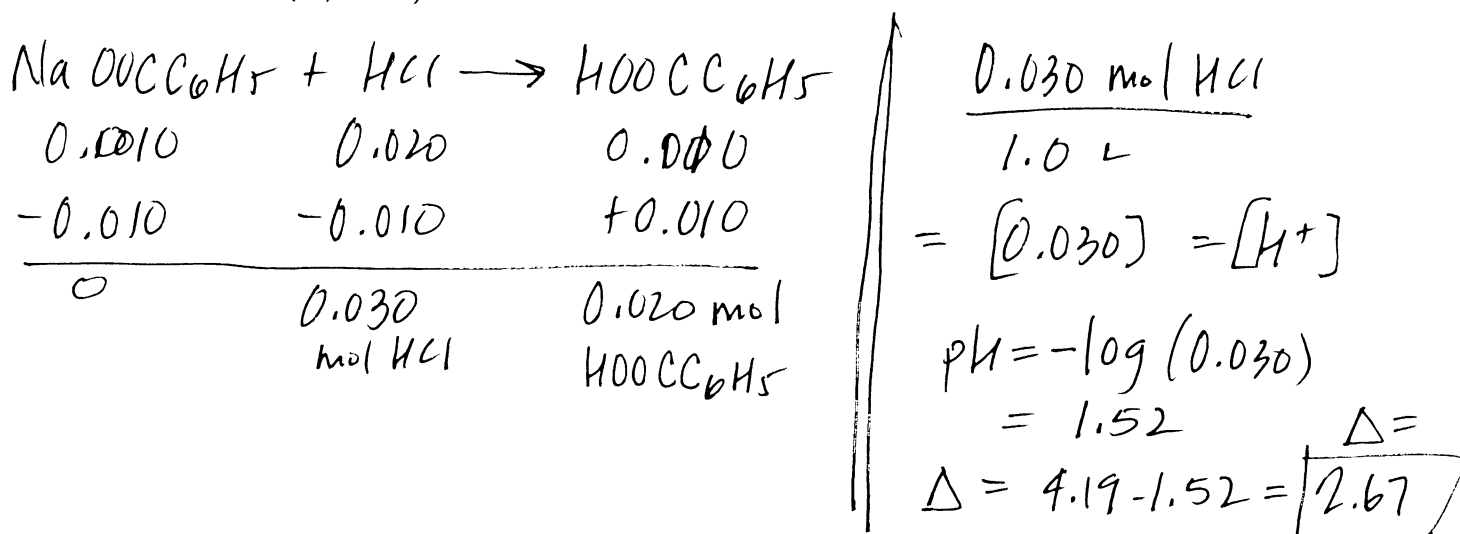


Unless otherwise specified, each question is worth 4 points.

3. Calculate the change in pH that occurs when 0.020 moles of HCl is added to 1.0 L of each of the following solutions:
- a. 5.0 M benzoic acid, HOOC_6H_5 ($K_a=6.5 \times 10^{-5}$) and 5.0 M sodium benzoate, NaOOC_6H_5 . (2 points)



- b. 0.010 M benzoic acid, HOOC_6H_5 ($K_a=6.5 \times 10^{-5}$) and 0.010 M sodium benzoate, NaOOC_6H_5 . (2 points)



- c. Both of the solutions are buffers made from the same compounds, but they behaved differently. Briefly explain. (2 points)

THE BUFFERING CAPACITY IN 3a WAS MUCH GREATER THAN IN 3b.



Unless otherwise specified, each question is worth 4 points.

4. Consider a titration of benzoic acid, HOOC_6H_5 ($K_a = 6.5 \times 10^{-5}$) with a strong base, 0.100 M NaOH . If 22.08 mL of base solution is required to completely react with the acid, what was the pH when 11.04 mL of base solution had been added?

11.04 mL IS THE $\frac{1}{2}$ -WAY POINT: $\text{pH} = \text{p}K_a$

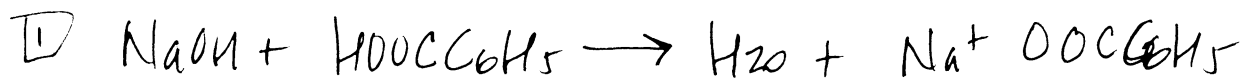
$$\boxed{\text{pH} = 4.19}$$

THE LONG WAY:

$$22.08 \text{ mL} \times \frac{0.100 \text{ mol NaOH}}{\text{L}} = 2.208 \text{ mmol OH}^-$$

$$= 2.208 \text{ mmol HOOC}_6\text{H}_5 \text{ (INITIAL)}$$

@ 11.04 mL : $11.04 \text{ mL} \times \frac{0.100 \text{ mol}}{\text{L}} = 1.104 \text{ mmol NaOH}$



1.104	2.208 mmol	—	\ominus
1.104			
mmol			
- 1.104	- 1.104	—	+ 1.104
\varnothing	1.104 mmol		1.104 1.104
	HOOC}_6\text{H}_5		mmol } \text{OOC}_6\text{H}_5

[2] BUFFER, OR EQUILIBRIUM CALC. w/ $K_a = 6.5 \times 10^{-5}$

