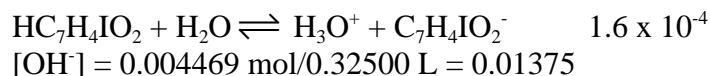


SHOW YOUR WORK. NO WORK, NO CREDIT!

1. The pH of a buffer in which the concentration of $\text{HC}_7\text{H}_4\text{IO}_2$ is 0.1375 M and the concentration of $\text{C}_7\text{H}_4\text{IO}_2^-$ is 0.1725 is 3.89. If 0.004469 moles of NaOH are added to 325.00 mL of this buffer, what is the change in pH (ΔpH)? (10 points)



	$\text{HC}_7\text{H}_4\text{IO}_2$	+	OH^-	\rightleftharpoons	H_2O	+	$\text{C}_7\text{H}_4\text{IO}_2^-$
I	0.1375		0.01375				0.1725
C	-0.01375		-0.01375				+0.01375
I	0.1237 ₅		0				0.1862 ₅
C	+x		+x				-x
E _x	0.1237 ₅ + x		x				0.1862 ₅ - x
E	≈ 0.1237 ₅						≈ 0.1862 ₅

$$K_b = \frac{1.00 \times 10^{-14}}{1.6 \times 10^{-4}} = 6.2_5 \times 10^{-11} = \frac{0.1237_5 x}{0.1862_5}; x = 9.4_1 \times 10^{-11}$$

$$[\text{OH}^-] = 9.4_1 \times 10^{-11} \text{ M}; \text{pOH} = 10.03; \text{pH} = 3.97$$

$$\Delta\text{pH} = 3.97 - 3.89$$

$$\Delta\text{pH} = \underline{\quad 0.08 \quad}$$

2. Determine the pH of a buffer that is 0.1250 M in CH_3NH_2 and 0.1750 M in $\text{CH}_3\text{NH}_3\text{Cl}$.

(8 points)

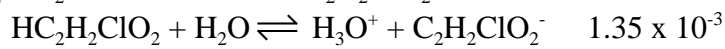
	$\text{CH}_3\text{NH}_2 + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{NH}_3^+ + \text{OH}^-$	$K_b = 4.2 \times 10^{-4}$
I	0.1250 0.1750 0	
C	-x +x +x	
E _x	0.1250 - x 0.1750 + x x	
E	≈ 0.1250 =0.1750	

$$K_b = \frac{0.1750x}{0.1250} = 4.2 \times 10^{-4}; x = 3.0 \times 10^{-4}; [\text{OH}^-] = 3.0 \times 10^{-4} \text{ M}$$

$$\text{pOH} = 3.52$$

$$\text{pH} = \underline{\quad 10.48 \quad}$$

3. Describe the preparation of 750.0 mL of a buffer with a pH of 3.16 if solutions of 0.1650 M $\text{HC}_2\text{H}_2\text{ClO}_2$ and 0.1275 M $\text{NaC}_2\text{H}_2\text{ClO}_2$ are to be used. (10 points)



$$[\text{H}_3\text{O}^+] = 0.00069_2 \text{ M}$$

$$\frac{[\text{C}_2\text{H}_2\text{ClO}_2^-] 0.00069_2}{[\text{HC}_2\text{H}_2\text{ClO}_2]} = 1.35 \times 10^{-3}; \frac{[\text{C}_2\text{H}_2\text{ClO}_2^-]}{[\text{HC}_2\text{H}_2\text{ClO}_2]} = 1.9_5$$

$$[\text{HC}_2\text{H}_2\text{ClO}_2] = \frac{x \cdot 0.1650}{750.0}; [\text{C}_2\text{H}_2\text{ClO}_2^-] = \frac{y \cdot 0.1275}{750.0}$$

$$x + y = 750.0; x = 750.0 - y$$

$$[\text{HC}_2\text{H}_2\text{ClO}_2] = \frac{(750.0 - y) \cdot 0.1650}{750.0}$$

$$\frac{\frac{y \cdot 0.1275}{750.0}}{\frac{(750.0 - y) \cdot 0.1650}{750.0}} = 1.9_5; \frac{y \cdot 0.1275}{(750.0 - y) \cdot 0.1650} = 1.9_5$$

$$0.1275y = 241.31 - 0.3218y$$

$$y = 537; x = 213$$

volume of $\text{HC}_2\text{H}_2\text{ClO}_2 = \underline{\quad 213 \text{ mL} \quad}$ volume of $\text{NaC}_2\text{H}_2\text{ClO}_2 = \underline{\quad 537 \text{ mL} \quad}$

4. HCl is titrated with NaOH. Determine the pH of 65.00 mL of 0.1815 M HCl after 80.00 mL of 0.1650 M NaOH have been added. (8 points)

$$[\text{H}_3\text{O}^+] = 0.1815 \text{ M} \times \frac{65.00 \text{ mL}}{145.00 \text{ mL}} = 0.08136 \text{ M}$$

$$[\text{OH}^-] = 0.1650 \times \frac{80.00 \text{ mL}}{145.00 \text{ mL}} = 0.09103 \text{ M}$$

$$0.09103 \text{ M} - 0.08136 \text{ M} = 0.00967 \text{ M OH}^-$$

$$\text{pOH} = 2.01$$

$$\text{pH} = \underline{\hspace{2cm}} 11.99 \underline{\hspace{2cm}}$$

5. $\text{HC}_7\text{H}_5\text{O}_2$ is titrated with NaOH. Determine the pH of 45.00 mL of 0.1150 M HNO_2 after 55.00 mL of 0.07500 M NaOH have been added.



$$[\text{HC}_7\text{H}_5\text{O}_2] = 0.1150 \text{ M} \times \frac{45.00 \text{ mL}}{100.00 \text{ mL}} = 0.05175 \text{ M}$$

$$[\text{OH}^-] = 0.07500 \text{ M} \times \frac{55.00 \text{ mL}}{100.00 \text{ mL}} = 0.04125 \text{ M}$$

	$\text{HC}_7\text{H}_5\text{O}_2$	+	OH^-	\rightleftharpoons	$\text{C}_7\text{H}_5\text{O}_2^-$	+	H_2O
I	0.05175		0.04125		0		
C	-0.04125		-0.04125		+0.04125		
I	0.01050		0		0.04125		
C	+x		+x		-x		
E_x	$0.01050 + x$		x		$0.04125 - x$		
E	≈ 0.01050				≈ 0.04125		

$$K_b = \frac{1.00 \times 10^{-14}}{6.3 \times 10^{-5}} = 1.58 \times 10^{-10} = \frac{0.01050x}{0.04125}; x = 6.24 \times 10^{-10}$$

$$[\text{OH}^-] = 6.24 \times 10^{-10} \text{ M}; \text{pOH} = 9.21$$

$$\text{pH} = \underline{\hspace{2cm}} 4.79 \underline{\hspace{2cm}}$$

6.

Indicator	pK _a	Acid color	Base color
Methyl Orange	3.46	Red	Orange
Bromocresol Green	4.66	Yellow	Blue
Methyl Red	5.00	Red	Yellow
Phenol Red	7.81	Yellow	Red
Phenolphthalein	9.90	Colorless	Red

A solution has a pH of 4.25. What color will each indicator exhibit in this solution?

(6 points)

phenolphthalein _____colorless_____

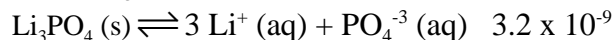
phenol red _____yellow_____

methyl red _____red-orange_____

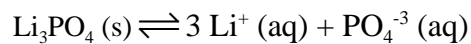
bromocresol green _____yellow-green_____

methyl orange _____orange_____

7. Calculate the solubility of $\text{Li}_3(\text{PO}_4)_2$ in a solution that is 0.01350 M in Li_2SO_4 . (8 points)



$$\frac{0.01350 \text{ mol Li}_2\text{SO}_4}{\text{L}} \times \frac{2 \text{ mol Li}^+}{1 \text{ mol Li}_2\text{SO}_4} = 0.02700 \text{ M Li}^+$$

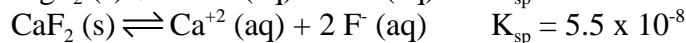
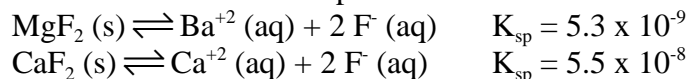


I	0.02700	0
C	+3x	x
E _x	0.02700+3x	x
E	≈ 0.02700	

$$(0.02700)^3 x = 3.2 \times 10^{-9}; \quad x = 1.6 \times 10^{-4}$$

$$S = \underline{1.6 \times 10^{-4} \text{ M}}$$

8. The concentration of Ba^{2+} in a water sample is 0.00008500 M and the concentration of Ca^{2+} in the water sample is 0.0950 M. It is desired to separate these two ions in this sample by the slow addition of NaF.



(a) Which ion will precipitate first and at what $[\text{F}^-]$? (6 points)

$$0.0008500[\text{F}^-]^2 = 5.3 \times 10^{-9}; [\text{F}^-] = 0.0079 \text{ M}$$

$$0.0950[\text{F}^-]^2 = 5.5 \times 10^{-8}; [\text{F}^-] = 0.0076 \text{ M}$$

ion = _____ Ca^{2+} _____ $[\text{F}^-] =$ _____ 0.00076 M _____

(b) What will be the concentration of the first ion to precipitate when the second ion just begins to precipitate? (4 points)

$$[\text{Ca}^{+2}] (0.00079)^2 = 5.5 \times 10^{-8}$$

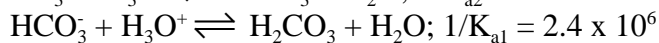
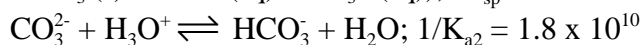
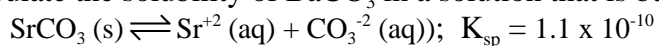
concentration = 8.8 x 10⁻⁴ M

(c) Is the separation effective? (2 points)

>10⁻⁶ M

Answer _____ No _____

9. Calculate the solubility of BaCO_3 in a solution that is buffered to a pH of 4.75. (10 points)

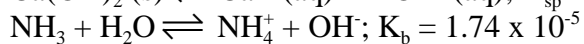
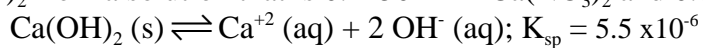


	$\text{SrCO}_3(\text{s}) + 2 \text{H}_3\text{O}^+ \rightleftharpoons \text{Sr}^{+2}(\text{aq}) + \text{H}_2\text{CO}_3 + 2 \text{H}_2\text{O}$	$K = 4.75 \times 10^6$
I	1.78×10^{-5}	0
C	-----	+x
E _x	-----	x
E	1.78×10^{-5}	

$$\frac{x^2}{(1.78 \times 10^{-5})^2} = 4.75 \times 10^6; x = 0.039$$

$$S = \underline{\hspace{2cm}} 0.039 \text{ M} \underline{\hspace{2cm}}$$

10. What concentration of NH_4^+ must be maintained in order to prevent the precipitation of $\text{Ca}(\text{OH})_2$ from a solution that is 0.2250 M in $\text{Ca}(\text{NO}_3)_2$ and 0.01625 M in NH_3 ? (10 points)



$$0.2250[\text{OH}^-]^2 = 5.5 \times 10^{-6}; [\text{OH}^-] = 4.9_4 \times 10^{-3} \text{ M}$$

$$\frac{[\text{NH}_4^+] \times 4.9_4 \times 10^{-3}}{0.01625} = 1.74 \times 10^{-5}$$

$$[\text{NH}_4^+] = \underline{\hspace{2cm}} 5.75 \times 10^{-5} \text{ M} \underline{\hspace{2cm}}$$

11. What H_3O^+ concentration must be maintained in a saturated H_2S solution in order to separate 0.395 M Zn^{+2} and 0.175 M Ni^{+2} as their sulfide salts? ZnS (s) will precipitate when $[\text{S}^{-2}] = 2.53 \times 10^{-21} \text{ M}$ and NiS (s) will precipitate when $[\text{S}^{-2}] = 1.71 \times 10^{-18} \text{ M}$. (8 points)

$$K = \frac{[\text{S}^{-2}][\text{H}_3\text{O}^+]^2}{0.10} = 1.1 \times 10^{-21}$$

$$\frac{2.53 \times 10^{-21} [\text{H}_3\text{O}^+]^2}{0.10} = 1.1 \times 10^{-21}; [\text{H}_3\text{O}^+] = 0.21 \text{ M}$$

$$\frac{1.71 \times 10^{-18} [\text{H}_3\text{O}^+]^2}{0.10} = 1.1 \times 10^{-21}; [\text{H}_3\text{O}^+] = 0.0080 \text{ M}$$

$$\underline{\hspace{1cm}} 0.0080 \text{ M} \underline{\hspace{1cm}} < [\text{H}_3\text{O}^+] < \underline{\hspace{1cm}} 0.21 \text{ M} \underline{\hspace{1cm}}$$