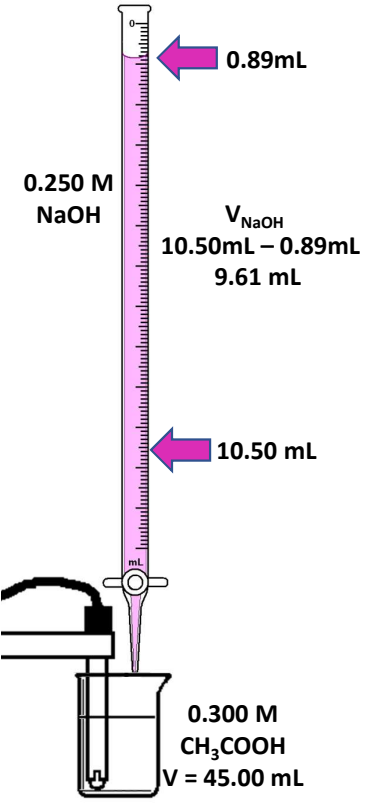
Type 1 Buffering Region

45.00 mL of 0.300 M CH_3COOH is titrated with 0.250 M NaOH.
Initially, the burette reads 0.89 mL.
What is the pH of the solution when the burette reads 10.50 mL?



Initial Moles

$moles_{CH3COOH} = Conc_{CH3COOH} \times Vol_{CH3COOH}$

$moles_{CH3COOH} = 0.300\ M \times 0.0450\ L$

$moles_{CH3COOH} = 0.0135_{00}\ mol_{CH3COOH}$

$>$

$moles_{NaOH} = Conc_{NaOH} \times Vol_{NaOH}$

$moles_{NaOH} = 0.250\ M \times 0.00961\ L$

$moles_{NaOH} = 0.00240_{25}\ mol_{NaOH}$

Neutralization: NaOH is neutralized by CH_3COOH

	Excess $CH_3COOH_{(aq)}$	+	Limiting $NaOH_{(aq)}$	→	Insignificant $H_2O_{(l)}$	+	$CH_3COO^-_{(aq)}$	+	Spectator $Na^+_{(aq)}$
$Initial_{moles}$	0.0135_{00} mol		0.00240_{25} mol						
Change	- 0.00240_{25} mol		- 0.00240_{25} mol		~		+ 0.00240_{25} mol		
$Final_{moles}$	0.0110_{975} mol		0.0 mol				0.00240_{25} mol		

Re-Calculation of Concentrations

$Volume_{Total}$	$[CH_3COOH]$	$[CH_3COO^-]$
$Vol_{CH3COOH}$ + Vol_{NaOH}	$mol_{CH3COOH}$ / $Vol_{CH3COOH}$	$mol_{CH3COO-}$ / Vol_{CH3COO}
45.00 mL + 9.61 mL	0.0110_{975} mol / 0.05461 L	+ 0.00240_{25} mol / 0.05461 L
54.61 mL = 0.05461 L	0.203_{21} M	0.0439_{93} M

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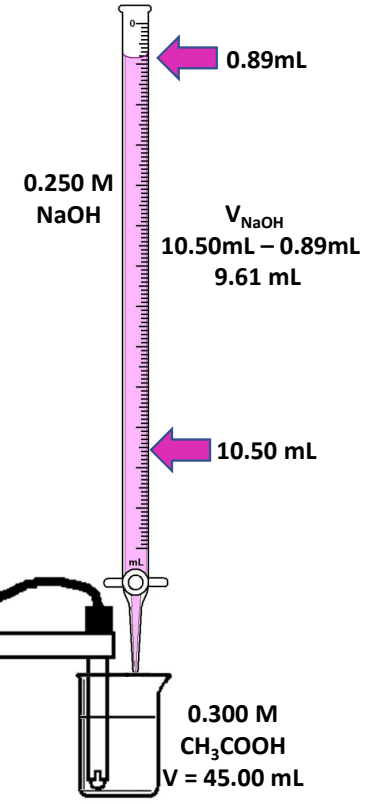


	$CH_3COOH_{(aq)}$	+	$H_2O_{(l)}$	→	$H_3O^+_{(l)}$	+	$CH_3COO^-_{(aq)}$	$K_a = 1.76 \times 10^{-5}$
I	0.203_{21} M		~		0.0 M		0.0439_{93} M	
C	-x				+x		+x	
E	0.203_{21} -x				x		0.0439_{93} +x	

L.M.A.

$$\frac{[H_3O^+]\ [CH_3COO^-]}{[CH_3COOH]} = \frac{x\ (0.0439_{93}+x)}{(0.203_{21}-x)} = \frac{x\ (0.0439_{93})}{(0.203_{21})} = K_a = 1.76 \times 10^{-5}$$

X ~ 0 Approximation (numerator)

X ~ 0 Approximation (denominator)

$$[H_3O^+] = x = 8.12_{9693} \times 10^{-5} M$$

pH Determination

$$pH = -\log[H_3O^+] = -\log(8.12_{9693} \times 10^{-5}) = 4.089_{92}$$

3 S.F. (for 8.12_{9693})

3 S.F. (for 4.089_{92})

Type 1 Buffering Region

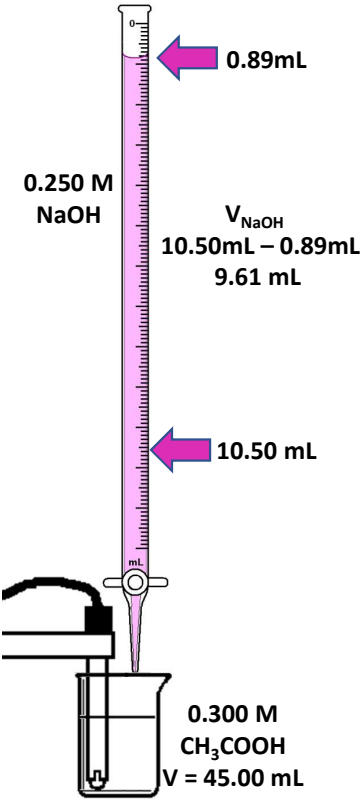
45.00 mL of acetic acid, CH_3COOH is titrated with 0.250 M NaOH.
Initially, the burette reads 0.89 mL.
What is the pH of the solution when the burette reads 10.50 mL?

$moles_{NaOH} = 0.250\ M \times 0.00961\ L$

$moles_{NaOH} = 0.00240_{25}\ mol_{NaOH}$

$moles_{CH3COOH} = 0.300\ M \times 0.0450\ L$

$moles_{CH3COOH} = 0.0135_{00}\ mol_{CH3COOH}$



		$CH_3COOH_{(aq)}$	+	$H_2O_{(l)}$	→	$H_3O^+_{(l)}$	+	$CH_3COO^-_{(aq)}$
Neutralization	$Initial_{moles}$	0.0135_{00} mol						0.0 mol
	$Change_{NaOH}$	-0.00240_{25} mol						$+0.00240_{25}$ mol
	$Final_{moles}$	0.0110_{975} mol						0.00240_{25} mol

Equilibrium					
		0.0110_{975} mol / 0.04461 L			$+0.00240_{25}$ mol / 0.04461 L
	I	0.248_{76} M	~	0.0 M	0.0538_{56} M
	C	-x	~	+x	+x
	E	0.248_{76} -x		x	0.0538_{56} +x

L.M.A.

$$\frac{[CH_3COOH]\ [CH_3COO^-]}{[H_3O^+]} = \frac{x\ \ (0.0538_{56}+x)}{(0.248_{76}-x)} = \frac{x\ \ (0.0538_{56})}{(0.248_{76})} = K_a = 1.76 \times 10^{-5}$$

X ~ 0 Approximation (numerator)

X ~ 0 Approximation (denominator)

$[H_3O^+] = x = 9.12_{9411} \times 10^{-5} M$ (3 S.F.)

$pH = -\log[H_3O^+] = -\log(9.12_{9411} \times 10^{-5}) = 4.089_{94}$ (3 S.F.)