$N_A = 6{,}023.10^{23}$ ▪ N_A ▪ N	$n = \frac{N}{N_A}$	**n** **mol**
g/mol ▪ M g ▪ m	$n = \frac{m}{M}$	
▪ V_g $L/$ ▪ V_M	$n = \frac{V_g}{V_M}$	
mol ▪ n L ▪ V	$c = \frac{n}{V}$	**mol/L** **c**
g ▪ m L ▪ V	$c_m = \frac{m}{V}$	**g/L** **t** **c_m**
g ▪ m mL ▪ V	$\rho = \frac{m}{V}$	**g/mL** **ρ**
▪ ρ_e $\rho_e = 1\ g/ml = 1kg/l$ ▪ ρ	$d = \frac{\rho}{\rho_e}$	**d**
▪ c_1 ▪ c_2 ▪ V_1 ▪ V_2 ▪ $V_e = V_2 - V_1$	$c_1V_1 = c_2V_2$	
▪ c_1 ▪ c_2 ▪ V_1 ▪ V_2	$F = \frac{c_1}{c_2} = \frac{V_2}{V_1}$	**F**
▪ P ▪ d ▪ M	$C = \frac{10\,.P.d}{M}$	
▪ m ▪ m'	$P = \frac{m}{m'} \times 100$	
▪ $K = \frac{S}{L}$ A ▪ I V ▪ U ▪ σ	$G = \frac{I}{U} = K\sigma$	**S** **G**
▪ λ_1 mol/m^3 ▪ $[X]$	$\sigma = \lambda_1[X_1] + \lambda_2[X_2] + ..$	**S/m** **σ**

$B_{(aq)} + H_2O_{(l)} = BH^+{}_{(aq)} + OH^-{}_{(aq)}$ $[OH^-] < C \quad \tau_f < 1 \quad K < 10^4$ $[OH^-] = C \quad \tau_f = 1 \quad K > 10^4$	$HA_{(aq)} + H_2O_{(l)} = H_3O^+{}_{(aq)} + A^-{}_{(aq)}$ $[H_3O^+] < C \quad \tau_f < 1 \quad K < 10^4$ $[H_3O^+] = C \quad \tau_f = 1 \quad K > 10^4$
$[HO^-] = \frac{10^{-14}}{[H_3O^+]} \Longrightarrow [HO^-] = 10^{pH-14}$	$\text{pH} = -\log[H_3O^+] \Longrightarrow [H_3O^+] = 10^{-pH}$
$\tau_f = \frac{x_f}{x_{max}} = \frac{[HO^-]}{C} = \frac{10^{pH-14}}{C}$	$\tau_f = \frac{x_f}{x_{max}} = \frac{[H_3O^+]}{C} = \frac{10^{-pH}}{C}$

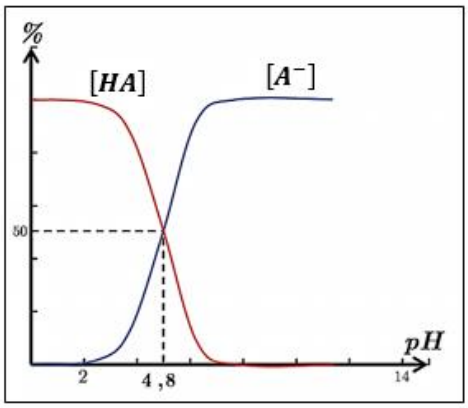
$$Ke = [H_3O^+]\times[HO^-] = 10^{-14}$$

$aA + bB = cC + dD$ K Q_r

$$Q_r = \frac{[C]^c\times[D]^d}{[A]^a\times[B]^b} \quad , \quad K = Q_{rf} = \frac{[C]^c{}_f\times[D]^d{}_f}{[A]^a{}_f\times[B]^b{}_f}$$

$[H_2O] = 1$

$K = \frac{[BH^+]_f\times[OH^-]_f}{[B]_f} = \frac{[BH^+]_f\times[OH^-]_f\times[H_3O^+]}{[B]_f\times[H_3O^+]}$ $K = \frac{Ke}{K_a}$	$K_a = \frac{[A^-]_f\times[H_3O^+]_f}{[HA]_f}$ $pK_a = -\log K_a \Longrightarrow K_a = 10^{-pK_a}$ $\text{pH} = pK_a + \log\frac{[A^-]_f}{[HA]_f}$



$[A^-]_f = [HA]_f \quad \text{pH} = pK_a$

$[A^-]_f < [HA]_f \quad \text{pH} < pK_a$

$[A^-]_f > [HA]_f \quad \text{pH} > pK_a$

$\text{pH} = pK_a$

$$[HA]_f = \frac{[HA]_f}{[HA]_f + [A^-]_f}\times 100 \; ; \; [A^-]_f = \frac{[A^-]_f}{[HA]_f + [A^-]_f}\times 100$$

•

(HIn/In^-)

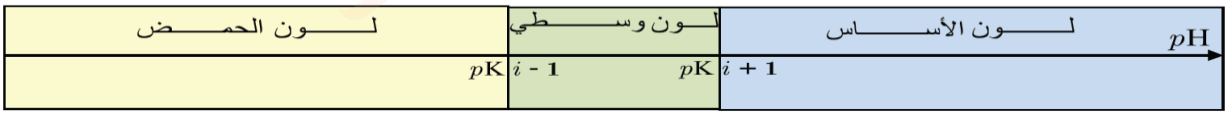
$$HIn_{(a)} + H_2O_{(l)} = H_3O^+{}_{(aq)} + In^-{}_{(aq)}$$

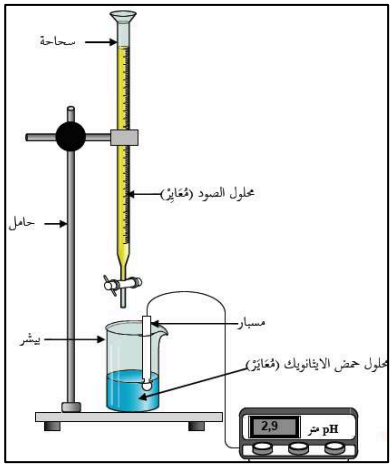
$$K_i = \frac{[In^-]_f\times[H_3O^+]_f}{[HIn]_f} \Longrightarrow \text{pH} = pK_i + \log\frac{[In^-]_f}{[HIn]_f}$$

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pH $R = \frac{[In^-]_f}{[HIn]_f}$

- In^- $\text{pH} \geq pK_i + 1$ $R \geq 10$
- HIn $\text{pH} \leq pK_i - 1$ $R \leq 10$
- $pK_i - 1 \leq \text{pH} \leq pK_i + 1$





V

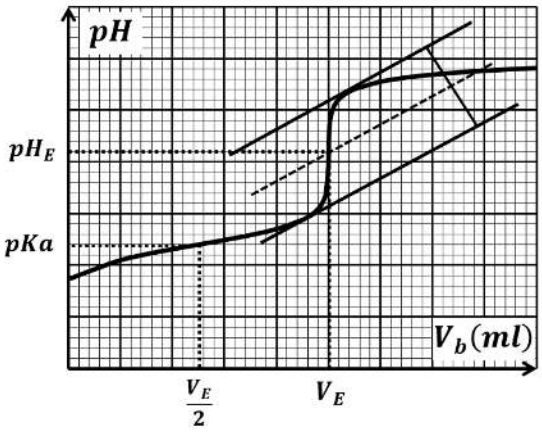
- $C_aV_a = C_bV_E$
-

$$[A^-] = [HA] \Longrightarrow V_b = \frac{V_E}{2} \Longrightarrow pH = pKa$$

$$H_3O^+{}_{aq} + OH^-{}_{aq} = 2H_2O$$

$$K = \frac{1}{[OH^-] \times [H_3O^+]} = \frac{1}{Ke}$$

$$\tau_f = \frac{x_f}{x_{max}} = \frac{C_aV_a - [H_3O^+]V_T}{C_bV_b} = \frac{C_aV_a - 10^{-pH}V_T}{C_bV_b} \quad V_b < V_E$$



- $HA_{(aq)} + HO^- = A^-{}_{(aq)} + H_2O_{(l)}$
-

$HA_{(aq)}$ + HO^- =	$A^-{}_{(aq)} + H_2O_{(l)}$		
C_aV_a	C_bV_b	0	
$C_aV_a - x_f$	$C_bV_b - x_f$	x_f	

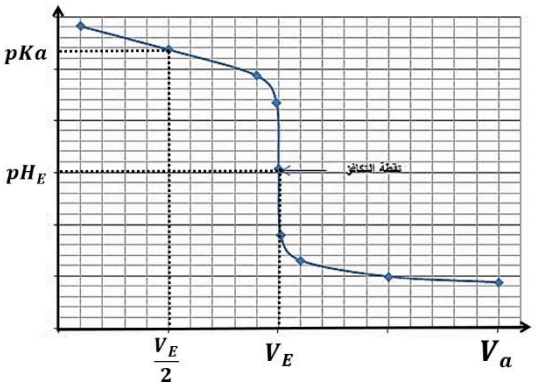
- $\tau_f = \frac{x_f}{x_{max}}$ $V_b < V_E$

$C_bV_b - x_{max} = 0 \Longrightarrow x_{max} = C_bV_b$ HO^-

$$[HO^-] = \frac{C_bV_b - x_f}{V_T} \Longrightarrow x_f = C_bV_b - [HO^-]V_T = C_bV_b - 10^{pH-14}V_T$$

$$\tau_f = \frac{x_f}{x_{max}} = \frac{C_b V_b - 10^{pH-14} V_T}{C_b V_b}$$

- $$K = \frac{[A^-]}{[HA]\times[OH^-]} = \frac{[A^-]\times[H_3O^+]}{[HA]\times[OH^-]\times[H_3O^+]} = \frac{Ka}{Ke}$$



- $B_{(aq)} + H_3O^+ = BH^+{}_{(aq)} + H_2O_{(l)}$
-

$B_{(aq)}$ +	H_3O^+ =	$BH^+{}_{(aq)}$ +	$H_2O_{(l)}$
C_bV_b	C_aV_a	0	
$C_bV_b - x_f$	$C_aV_a - x_f$	x_f	

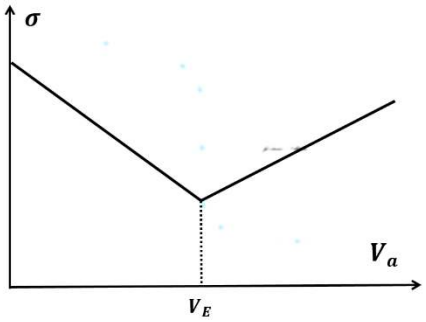
- $\tau_f = \frac{x_f}{x_{max}}$ $V_b < V_E$

$C_aV_a - x_{max} =$ H_3O^+

$0 \Longrightarrow x_{max} = C_aV_a$

$$[H_3O^+] = \frac{C_aV_a - x_f}{V_T} \Longrightarrow x_f = C_aV_a - [H_3O^+]V_T = C_aV_a - 10^{-pH}V_T$$

$$\tau_f = \frac{x_f}{x_{max}} = \frac{C_aV_a - 10^{-pH}V_T}{C_aV_a}$$



- $$K = \frac{[BH^+]}{[H]\times[[H_3O^+]]} = \frac{1}{Ka}$$
-

أ-

V_0

ب- $\boldsymbol{V}$ $\boldsymbol{c}$

$m = c\,VM$

V

ج- $\boldsymbol{P}$ $\boldsymbol{V}$ $\boldsymbol{c}$

V

د- $\boldsymbol{V}$ $\boldsymbol{c}$

V_0

V

- V_0
- $C = \frac{10\,.P.d}{M}$

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2008 1

İ

$$CH_3COOH_{(aq)} + H_2O_{(\ell)} = CH_3COO^-_{(aq)} + H_3O^+$$

1

$(acide/base)$ 2

K 3

pH $C = 2.7\times10^{-3}\,mol/L$ $V = 100mL$ İİ

3,7 25°C

1

x_{max} x_f 2

τ_f 3

$[CH_3COOH]_f$ $[CH_3COO^-]_f$ 4

(CH_3COOH/CH_3COO^-) pKa

2011 2

$C_0 = 0.01mol/l$ V_0 CH_3COOH S_0

1

$x_{éq}$ 2

3

$[H_3O^+]_f$ C_0 τ_f

$$Q_{r.éq} = \frac{[H_3O^+]^2_{éq}}{C_0 - [H_3O^+]_{éq}}$$

$[HO^-]_{éq}$ $[H_3O^+]_{éq}$ $\lambda_{CH_3COO^-}$ $\lambda_{H_3O^+}$ $\sigma_{éq}$

4

$\lambda_{CH_3COO^-} = 3.6mS.m^2.mol^{-1}$ $\lambda_{H_3O^+} = 35.9\,mS.m^2.mol^{-1}$

$Q_{r,eq}$	τ_f (%)	$\left[H_3O^+_{(aq)}\right]_{eq}\,(mol.L^{-1})$	$\sigma_{eq}\,(S.m^{-1})$	$c\,(mol.L^{-1})$	المحلول
			0,016	$1,0\times10^{-2}$	S_0
			0,036	$5,0\times10^{-2}$	S_1

$Q_{r.éq}$ τ_f -

:3

$C_1 = 10^{-2}\,mol/L$ $C_6H_5 - COOH$ (S_1) İ

$\sigma = 0{,}86\times10^{-2}$S/m 25°C

1

2

(S_1) 3

$\lambda_{C_6H_5-COO^-} = 4\,mS.m^2.mol^{-1}$ $\lambda_{H_3O^+} = 35.0\,mS.m^2.mol^{-1}$

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τ_{1f} 4

k_1 5

$25°C$ $pH = 3,2$ $C_2 = C_1$ HA (S_2) İİ

τ_{2f} 1

τ_{2f} τ_{1f} 2

2011 4

CH_3COOH

$$CH_3COOH(aq) + H_2O(\ell) = CH_3COO^-(aq) + H_3O^+(aq)$$

$\sigma = 1,6\times10^{-2}S/m$ $C_0 = 0.01mol/l$ 25°C

$(acide/base)$ 1

$[H_3O^+]_{éq}$ C_0 K 2

3

$\sigma(t) = \sum_{i=1}^{i=n} \lambda_i[X_i]$

$\sigma(t)$

4

5

K

τ_f

$\lambda_{CH_3COO^-} = 4.1mS.m^2.mol^{-1}$ $\lambda_{H_3O^+} = 35.9\ mS.m^2.mol^{-1}$

2008 5

G $C = 10^{-2}\ mol/L$ $V = 100mL$

$G = 1.92\times10^{-4}S$ $k = 1,2\times10^{-2}m$ $25°C$

V 1

2

V C x_{max} 3

σ 4

k G -

$\lambda_{H_3O^+}$ $[H_3O^+]$ -

$\lambda_{CH_3COO^-}$

$\lambda_{CH_3COO^-}$ $\lambda_{H_3O^+}$ k G $[H_3O^+]_f$

pH

Q_{rf} C $[H_3O^+]_f$ Q_{rf} 5

(CH_3COOH/CH_3COO^-) pKa 6

$\lambda_{H_3O^+} = 35.0\ mS.m^2.mol^{-1}$ $\lambda_{CH_3COO^-} = 4\ mS.m^2.mol^{-1}$

$M(H) = 1g/mol$ $M(C) = 12\ g/mol$ $M(O) = 16\ g/mol$

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2012 6

$C_1 = 10^{-2}\,mol/l$ C_6H_5COOH $V = 200ml$ S_1

$pH_1 = 3.1$ pH

1

2

3 τ_{1f}

4 $C_6H_5COOH/C_6H_5OO^-$ K_{a_1}

5 $K_{a_1} = C_1 \frac{{\tau_{1f}}^2}{1-\tau_{1f}}$ K_{a_1}

6 C'_1 S_1' S_1 $20ml$

$pH'_1 = 3.6$ pH

$C'_1 = 1\times10^{-3}\,mol/l$

τ_{2f}

2009 7

(mol/l) C CH_3COOH

1

2

3 τ_f C $[H_3O^+]$

4 $Ka = \frac{{\tau_f}^2.C}{1-\tau_f}$ (CH_3COOH/CH_3COO^-)

5 (C) τ

$C(mol.L^{-1})\times10^{-2}$	17,8	8,77	1,78	1,08
$\tau(\times10^{-2})$	1,0	1,4	3,1	4,0
$A = 1/C(L.mol^{-1})$				
$B = \tau^2/(1-\tau)$				

$A = f(B)$

(CH_3COOH/CH_3COO^-) ka

2012 8

25°C

$pH = 3.4$ $C_1 = 10^{-2}\,mol/l$ $CH_3 - COOH$ S_1 *i*

1

2

3 $CH_3 - COOH$

4 τ_{1f} $K_1 = C_1 \frac{{\tau_{1f}}^2}{1-\tau_{1f}}$ K_1

5

ii $C_2 = 10^{-1}\,mol/l$ S_2

$\sigma = 50ms.m^{-1}$

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1

K_2 τ_{2f} 2

3

$\lambda_{CH_3COO^-} = 4.1\ mS.m^2.mol^{-1}$ $\lambda_{H_3O^+} = 35.0\ mS.m^2.mol^{-1}$

2016 9

$M(C_6H_5COOH) = 122g/mol$ 25°C

C_6H_5COOH 1

$C_1 = 0.01\ mol/L$ $V_1 = 50mL$ (S_1) $C_6H_5OO^-$

$C_0 = 0.025\ mol/L$

V_0

(S_1)

$(50mL\ ,\ 100mL\ ,\ 500mL)$

$(5mL\ ,\ 10mL\ ,\ 20mL)$

1

3.12 (S_1) pH 2

Q_{rf}

(S_1) $10mL$ 3

pH

$V_{H_2O}(mL)$	0	10	40
$C(mol/L)$			
pH	3.12	3.28	3.49
τ_f			

τ_f c

2014 10

HA

$c(mol/L)$	$1,0\cdot10^{-2}$	$5,0\cdot10^{-3}$	$1,0\cdot10^{-3}$	$5,0\cdot10^{-4}$	$1,0\cdot10^{-4}$
pH	3,10	3,28	3,65	3,83	4,27
$[H_3O^+]_{éq}\ (mol\cdot L^{-1})$					
$[A^-]_{éq}\ (mol\cdot L^{-1})$					
$[HA]_{éq}\ (mol\cdot L^{-1})$					
$Log\frac{[A^-]_{éq}}{[HA]_{éq}}$					

25°C pH

:

1

HA

V C

HA 2

.

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. 3

(HA/A^-) pKa HA pH 4

. $pH = f\left(log\frac{[A^-]_{eq}}{[HA]_{eq}}\right)$ 5

HA (HA/A^-) pKa

الثنائية	$HCOOH\ /\ HCOO^-$	$C_2H_5COOH\ /C_2H_5COO^-$	$C_6H_5COOH\ /C_6H_5COO^-$
pK_a	3,8	4,87	4,2

.

2015 11

25°C pH = 2.9 $C = 0.01\,mol/l$ V HCOOH I

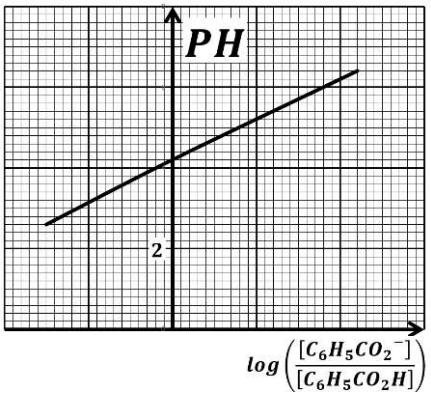
( ) 1

2

τ_f 3

$(HCOOH/HCOO^-)$ pKa 4

$\frac{[C_6H_5CO_2^-]}{[C_6H_5CO_2H]}$ C $C_6H_5CO_2H$ II



$\text{pH} = f\left(log\frac{[C_6H_5CO_2^-]}{[C_6H_5CO_2H]}\right)$

$(C_6H_5CO_2H/C_6H_5CO_2^-)$ Ka 1

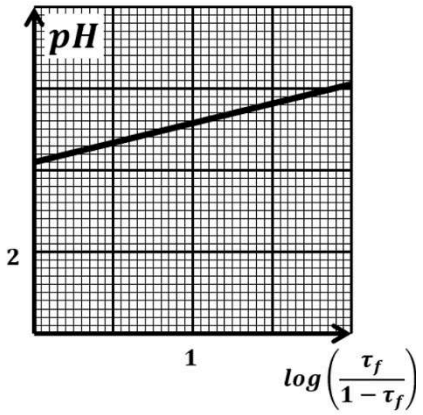
$(C_6H_5CO_2H/C_6H_5CO_2^-)$ pKa pH 2

$\frac{[C_6H_5CO_2^-]}{[C_6H_5CO_2H]}$

$(C_6H_5CO_2H/C_6H_5CO_2^-)$ pKa 3

$C_6H_5CO_2H$ $HCOOH$ 4

2016 12



C_0 HA S_0

HA 1

C_0 pH τ_f

S_0 pH

$pH = pKa + \log\left(\frac{\tau_f}{1-\tau_f}\right)$

C_0 2

$pH = f\left(log\left(\frac{\tau_f}{1-\tau_f}\right)\right)$ pH S_0

(HA/A^-) Ka

$\tau_f = 0.4$ HA

C_0 $pH = 4.2$ 160

HA (HA/A^-) pKa

HA/A^-	CH_3COOH/CH_3COO^-	$HCOOH/HCOO^-$	$C_6H_6COOH/C_6H_5COO^-$	
pKa	4.8	3.8	4.2	25°C

2010 13

$500\ ml$ $1{,}2\ L$ NH_3 (S_1)

$V_M = 24\ L/mol$ (S_1) C_1 1

11,1 25°C (S_1) pH 2

τ_{1f}

$V = 50\ ml$ (S_2) 3

(S_1) $C_b = 2\times10^{-2}mol/l$

(S_2)

τ_{2f} 10,8 (S_2) pH

$(NH_4^+(aq)/NH_3(aq))$ ka 4

14

$V = 100ml$ $C = 0.02\ mol/l$ NH_3 (S_1)

$\sigma = 15.3mS.m^{-1}$

1

2

3

τ_f 4

$(NH_4{}^+/NH_3)$ pka k 5

20 (S_1) $V_2 = 200ml$ (S_2)

(S_2) C_2 1

$pH = 10.08$ $\tau_{2f} = \frac{1}{1+10^{pH-pKa}}$ τ_{2f} 2

3

$Ke = 10^{-14}$ $\lambda_{NH_4{}^+} = 7.34\ mS.m^2/mol$ $\lambda_{OH^-} = 19.9\ mS.m^2/mol$

2013 15

$m = 0.72g$ CH_3COOH S_1 1

3.3 pH 25°C $800ml$

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أ- C_1 S_1

ب-

ج-

د- x_{eq} pH V V S_1

ه- pKa $CH_3COOH(aq)/CH_3COO^-(aq)$ 4.76

2 V_1 S_1 n_0 V_2 n_0

أ- CH_3COOH NH_3

ب- K

ج- τ_{eq} $\tau_{eq} = \frac{\sqrt{K}}{1+\sqrt{K}}$

د- τ_{eq}

$M(C) = 12\,g/mol$ ، $M(H) = 1\,g/mol$ ، $M(O) = 16\,g/mol$ ، $pKa(NH_4^+/NH_3) = 9.2$

16

CH_3COO^- $HCOOH$

$0.1mol$ $500ml$ CH_3COONa

$0.1mol$

1

2

3 Q_{ri}

4 τ_f

5 $K = 13$

6 τ_f

17

$V = 100\,ml$ pH 11,3 (S_0) CH_3NH_2 $C = 0.01\,mol/l$

1 ( )

2

3 τ_f

4 pKa $pka = 10.6$ $CH_3NH_3^+/CH_3NH_2$

5 CH_3NH_2 $(Na^+ + HCO_3^-)$

$n = CV$

$CH_3NH_{2(aq)} + HCO_{3\,(aq)}^- = CH_3NH_3^{+}{}_{(aq)} + CO_{3\,(aq)}^{2-}$

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k

x_f $k = \frac{(x_f)^2}{(CV - x_f)^2}$

$\tau`_f$

pH

$pka(HCO_3^-/CO_3^{2-}) = 10.3$ $Ke = 10^{-14}$

2012 18

25°C

C_6H_5COOH $500ml$ S

1

/ K_a 2

$(Na^+{}_{aq} + OH^-{}_{aq})$ $V_a = 20ml$ 3

V_b pH $C_b = 0.2\,mol/l$

أ-

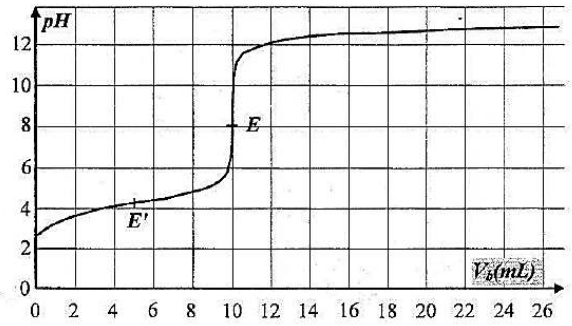
ب- E' E

ج- C_a

د- S m

ه- $C_6H_5COOH/C_6H_5COO^-$ K_a

و- $pH = 6$



$M(C) = 12\,g/mol$, $M(H) = 1\,g/mol$, $M(O) = 16\,g/mol$

2013 19

C_a $C_6H_5CO_2H$ $V_a = 20ml$

V_b $C_b = 10^{-1}\,mol/l$

$pH = f(V_b)$

1

pH 2

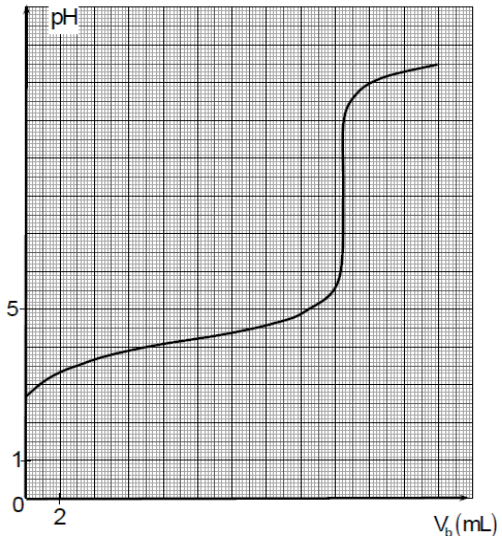
3

4

أ- C_a E

ب- $C_6H_5COOH/C_6H_5COO^-$ pKa

ج- $V_b = 0$ pH



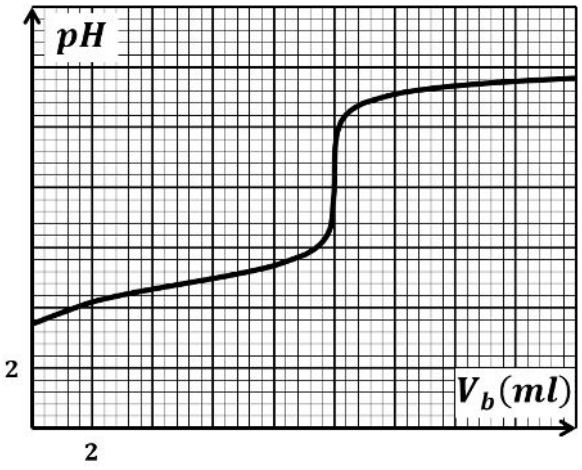
2016 20

$K_e = 10^{-14}$ 25°C

$V_a = 20mL$ HA C_a

pH $C_b = 0.02\,mol/L$ $(K^+ + HO^-)$

V_b $pH = f(V_b)$



1

C_a 2

(HA/A^-) pKa 3

(HA/A^-)	pKa
CH_3COOH/CH_3COO^-	4,8
$HCOOH/HCOO^-$	3,8
$C_6H_6COOH/C_6H_5COO^-$	4,2

HA 4

5

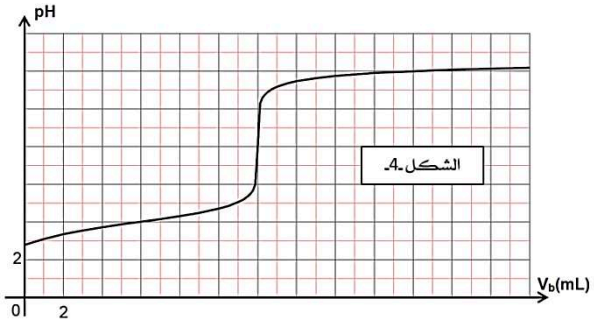
K

	6.2 7.6
	8.2 10.0
	4.2 6.2

2008 21

$CH_3CHOHCOOH$ $2.4\times10^{-2}\,mol/L$

HA



$V_a = 20mL$

$C_b = 5\times10^{-2}\,mol/L$

pH pH

$V_a = 20mL$

$200mL$

$V_a = 12.9mL$

1

2

3

4

5

2010 22

25°C

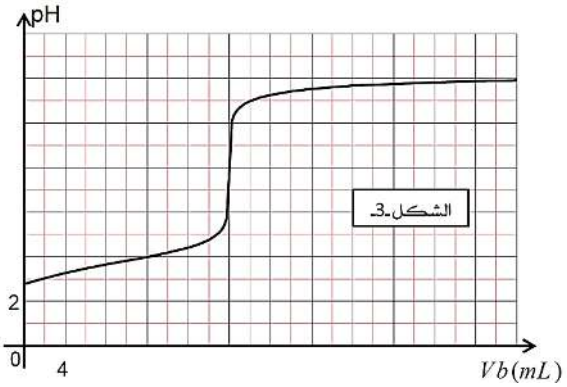
$HCOOH(aq)$ (S_0)

$180mL$ 10 (S_0) $V_0 = 20mL$

(S_1)

$(Na^+ + HO^-)$ (S_1) $V_1 = 20mL$

3 $C_b = 0.02\,mol/L$



1 (S_0)

2

3

(S_1)

4 ka

$(HCOOH(aq)/HCOO^-(aq))$

5 (S_0)

2010 23

C_6H_5COOH CO_2

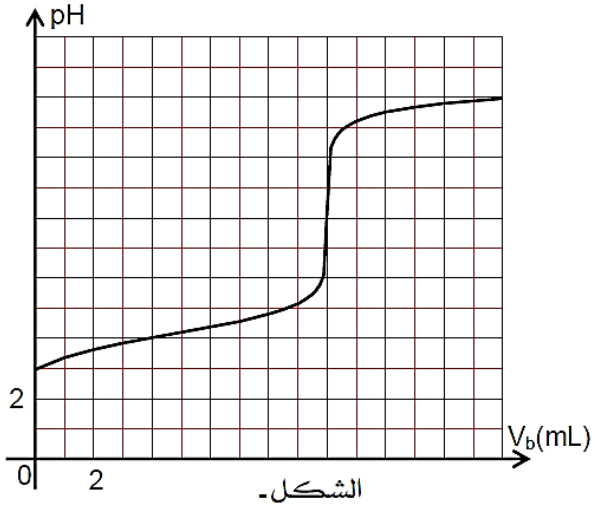
$V_a =$ C_a

CO_2 $50mL$

$C_b = 0.1\,mol/L$ $(Na^+ + HO^-)$

25°C pH V_b 1

1 $pH = f(V_b)$ pH



E

C_a

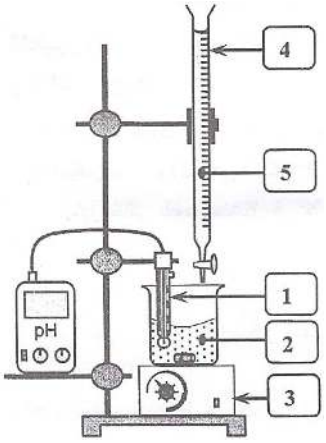
$V_b = 10mL$ 2

H_3O^+

3

إسم الكاشف	مجال التغير اللوني pH
أحمر الميثيل	6,2 - 4,2
أزرق البروموتيمول	7,6 - 6,0
الفينول فتالين	10,0 - 8,0

2016 24



25°C

HA HSO_3NH_2

$(P\%)$

C_A (S_A) 1

$m = 0.9g$ $V = 100mL$

(S_A)

$80mL$ $V_A = 20mL$ (S_A) 2

$C_b = 0.1\,mol/L$ $(Na^+ + HO^-)$

$pH_E = 7$ $V_{bE} = 15.3mL$

HA m_A (S_A) C_A

$(P\%)$

$M = 97g/mol$ HA

2010 25

$100\,ml$ m CH_3COOH (S)

3,4 25°C pH (S) pH

1

x_f 2

m $C = 0.01\,mol/L$ $\tau_f = 0.039$

(S)

Q_{rf} Q_{ri} 3

$V_a = 10mL$ (S) C 4

$C_b = 4\times10^{-3}mol/l$ $(Na^+ + HO^-)$

$V_{bE} = 25mL$

(S) C

$12,5\,ml$ pH

$M(H) = 1g/mol$ $M(C) = 12g/mol$ $M(O) = 16g/mol$ $pKa(CH_3COOH/CH_3COO^-) = 4,8$

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2013 26

$C = 10^{-2}\,mol/l$ V CH_3COOH S

$\sigma = 16ms.m^{-1}$ 25°C S σ

1

λ $\lambda_{H_3O^+}$ $\lambda_{CH_3COO^-}$ σ S $[H_3O^+]$ 2

3.4 pH 3

$(K^+{}_{aq} + OH^-{}_{aq})$ S V_a 4

$\frac{[CH_3COO^-(aq)]}{[CH_3COOH(aq)]} = 41.43\times10^{-3}$ $C_b = 2\times10^{-3}\,mol/l$

$\frac{[CH_3COO^-(aq)]}{[CH_3COOH(aq)]} = 1$ $V_b = 10ml$

$CH_3COOH(aq)/CH_3COO^-(aq)$ K_A

V_a

$\lambda_{CH_3COO^-} = 4.1\,mS.m^2.mol^{-1}$ $\lambda_{H_3O^+} = 35.0\,mS.m^2.mol^{-1}$

2015 27

$C_3H_6O_3$

$P = 45\%$

$M = 90g/mol$

$\rho = 1.13kg/l$

pH $C = 0.1\,mol/l$ $V = 500ml$ 1

25°C pH = 2.4

$(C_3H_6O_3/C_3H_5O_3{}^-)$ pKa

100 2

(S_a) $V_a = 10ml$ C_a (S_a)

$V_{bE} = 28.3ml$ $C_b = 0.02\,mol/l$ $(Na^+ + HO^-)$

C_0 C_a

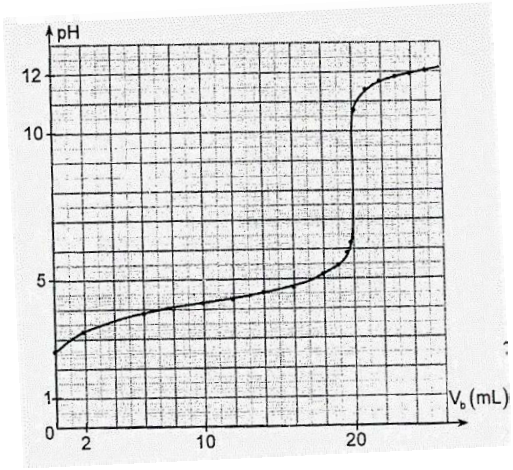
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$\rho = 1kg/l$

2015 28

C_a $C_6H_5CO_2H$ $V_a = 20ml$

$pH = f(V_b)$ $C_b = 0.1\ mol/l$ $(Na^+ + OH^-)$



V_b

1

E 2

C_a 3

$(C_6H_5CO_2H/C_6H_5CO_2^-)$ pKa 4

$14ml$ 5

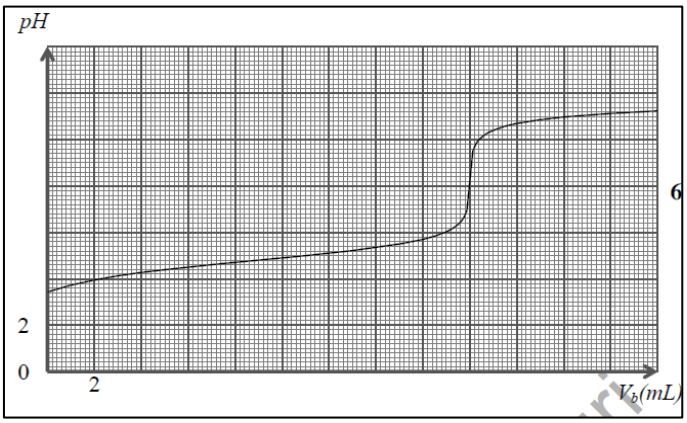
τ_f

25°C

2013 29

C_a CH_3COOH

25°C 3.8 pH 1



أ-

ب- C_a

$[H_3O^+]_{eq}$

ج- C_a

$\tau_{eq} = 0.0158$

$V_a = 18ml$ C_a 2

$ExAO$ $C_b = 10^{-2}\ mol/l$

أ-

ب- C_a $E(V_{bE}, pH_E)$

4.8 pH $V_b = 9ml$ 3

أ- pKa pH $\frac{[CH_3COO^-(aq)]}{[CH_3COOH(aq)]}$

ب- x x

ج- τ

$pKa(CH_3COOH(aq)/CH_3COO^-(aq)) = 4.8$

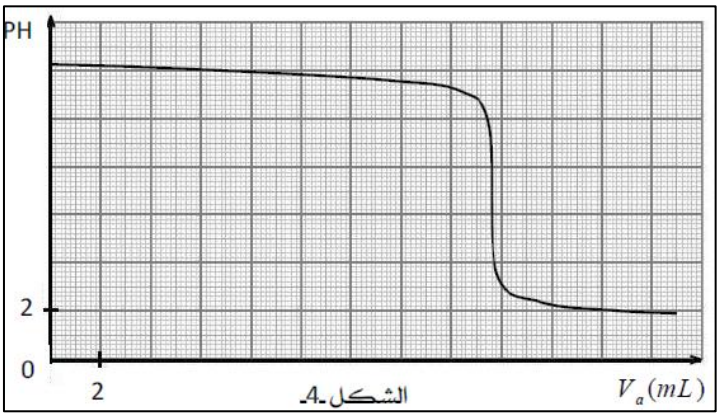
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2011 30

$d = 1,3$ 27% S_0

$C_0 = 8,8\ mol/l$ 1

$V_0 = 10\ ml$ $C_a = 0,1\ mol/l$



الشكل-4

50 S 2

500 ml

S

$V_b = 10\ ml$ 3

pH S

pH pH

pH

E $(V_{aE}\ ; PH_E)$

S

$M(H) = 1g/mol \quad M(Na) = 23g/mol \quad M(O) = 16g/mol$

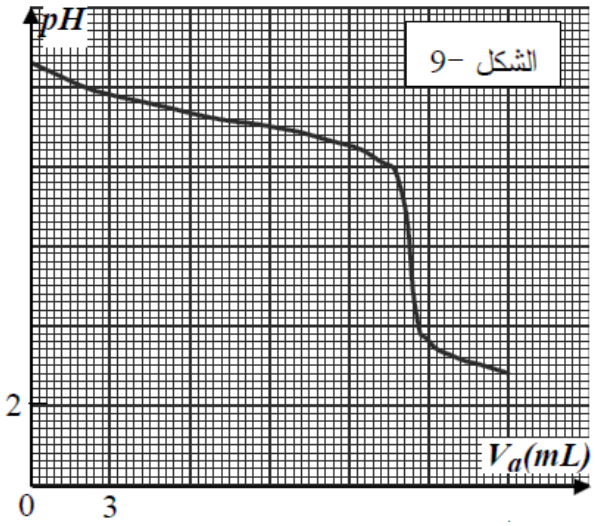
2014 31

pH NH_3 (S) C_b

$C_a = 0.015mol/L$ $(H_3O^+ + Cl^-)$ (S) $V_b = 20mL$

1

09 25°C 2



الشكل -9

C_b

NH_4^+/NH_3 pKa

K 3

$V_a = 9mL$ 4

$\frac{[NH_3]_f}{[NH_4^+]_f}$

x_f V_b C_b

τ_f

2015 32

NH_4NO_3

25°C 33%

$C_1 = 0.15\ mol/l$ NH_4^+ $V_1 = 20ml$ $t = 0$

pH $C_2 = 0.15\ mol/l$ $(Na^+ + HO^-)$ $V_2 = 10ml$

pH = 9.2

$$NH_4{}^+{}_{(aq)} + HO^-{}_{(aq)} = NH_{3(aq)} + H_2O_{(l)}$$

1

x_{max}

$x_{eq} = 1.5\times10^{-3}\ mol$

τ_f

$m = 6g$ 2

(S_a) $V_a = 10ml$ $250ml$ (S_a)

$V_{bE} = 14ml$ $C_b = 0.2\ mol/l$

(S_a) C_a

$M(H) = 1\ g/mol$,$M(N) = 14\ g/mol$,$M(O) = 16\ g/mol$ $PKa(NH_4^+/NH_3) = 9.2$

2012 33

$C_{13}H_{18}O_2$

$200mg$

$M(RCOOH) =$ $RCOO^-$ $RCOOH$

25°C $206\ g/mol$

C_0 S_0 $200mg$

$V_0 = 500ml$

$C_0 \approx 0.002\ mol/l$ 1

$pH = 3.5$ S_0 pH 2

Q_r

x_{max} τ_f $Q_{r_{eq}} = \frac{x_{max}\tau_f{}^2}{V_0(1-\tau_f)}$ Q_r

K

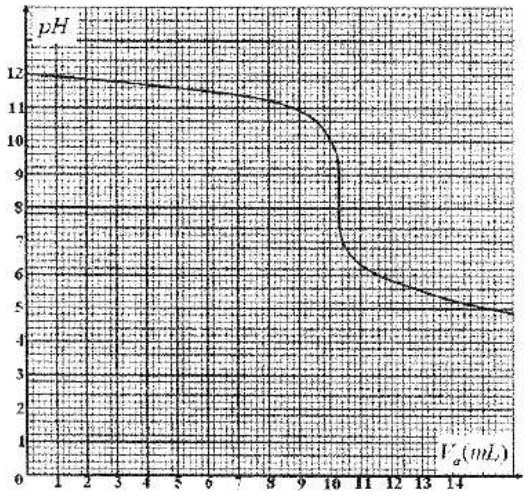
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S_b $V_b = 100ml$

S $C_b = 2\times10^{-2}\,mol/l$ $(Na^+{}_{aq} + OH^-{}_{aq})$

S $20ml$ V_b

$C_a = 2\times10^{-2}\,mol/l$



$H_3O^+{}_{aq} + OH^-{}_{aq} = 2H_2O$ 1

E 2

$OH^-{}_{aq}$ 3

$OH^-{}_{aq}$ 4

$RCOOH$

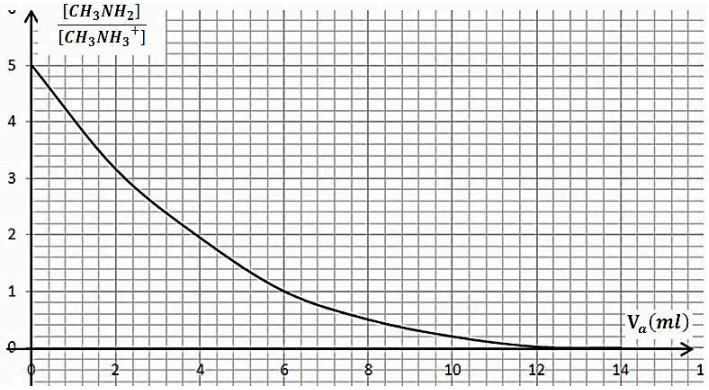
m

34

$CH_3NH_3{}^+{}_{(aq)}$ $CH_3NH_{2(aq)}$

(S)

$V_b = 20\ ml$ 10 (S_1)



$C_a = 0.02\ mol/l$

1

2

3

C_b 4

$V_a = 2.8ml$ 5

pH

τ_f

(S_1) 6

أ-

PH K_e C_b $\tau`_f$ ب-

$\tau`_f$

$K_e = 10^{-14}$ $PKa(CH_3NH_3{}^+/CH_3NH_2) = 10.6$

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35

100g d

$\rho = 1.02\ g/ml$

$200ml$ $100ml$

$20ml$ $10ml$

pH $100ml$

$C_b = 0.1\ mol/L$ $(Na^+ + OH^-)$

pH $V_1 = 100ml$ (S_1) 10

$C_b = 0.1\ mol/L$ (S_1) $V_a = 20ml$ 2.4

$(Na^+ + OH^-)$ $V_b = 13.75ml$ $\frac{[CH_3COO^-]}{[CH_3COOH]} = 3.98\times10^{-3}$

$\frac{[CH_3COO^-]}{[CH_3COOH]} = 1$

$pH < 7$ pH 1

(S_1) 2

CH_3COOH 3

C_0 (S_1) C_a

(CH_3COOH/CH_3COO^-) pka_1 4

$V_b = 15mL$ pH 5

$M_O = 16\ g/mol$ $M_H = 1\ g/mol$ $M_C = 12\ g/mol$

$pka_2(CH_3NH_3^+/CH_3NH_2) = 10.7$ $Ke = 10^{-14}$

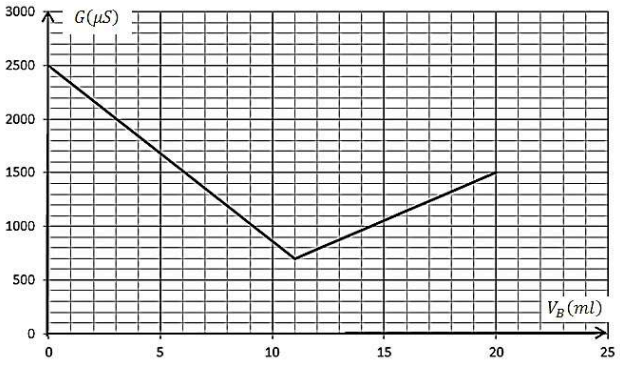
36

33%

1000 S_0 C_0 C_0 S_0

$V_1 = 100ml$ C_1 S_1

V_B $C_B = 0.01mol/l$



1

C_1 V_{BE} 2

S_0 C_0 3

4

S_0 $100g$

37

C_6H_5COOH CO_2

$V_a =$ C_a

$(Na^+ +$ CO_2 $50mL$

$pH =$ $V_b = 4mL$ $C_b = 0.1\,mol/L$ $HO^-)$

25°C 4

1

2

τ_f 3

k 4

$C_aV_a =$ V_b 5

C_a $C_b\,V_b(1 + 10^{pKa-pH})$

$pKa(C_6H_5COOH/C_6H_5OO^-) = 4.2$ $Ke = 10^{-14}$

38

$800ml$ $m = 0.48g$ $C_nH_{2n+1}COOH$ S_1

$pH = 3.39$ pH 25°C

C_a $pKa_1 = 4.76$ $C_nH_{2n+1}COOH/C_nH_{2n+1}COO^-$ pKa_1

S_1 $V_a = 20mL$ C_a 1

pH $V_b = 8ml$ $C_b = 2\times10^{-2}\,mol/l$ $(Na^+ + HO^-)$

$pH = 5.36$

K

$V_{bE} = V_b(1 + 10^{pKa-pH})$ V_b

V_{bE}

C_a

$H = 1\,g/mol$ $O = 16\,g/mol$ $C = 12\,g/mol$

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