

Azido eta baseak



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[1] Kalkulatu ondoko disoluzioaren pHa:

$$c_{\text{NH}_3} = 10^{-1} \text{ M}, K_a(\text{NH}_4^+/\text{NH}_3) = 10^{-9.55}$$

ERANTZUNA

Base ahul batez osatutako sistema da: $K_b(\text{NH}_4^+/\text{NH}_3) = 10^{-4.45}$



$$\text{Masa-balantzea: } c_{\text{NH}_3} = 10^{-1} \text{ M} = [\text{NH}_3] + [\text{NH}_4^+]$$

$$\text{Karga-balantzea: } [\text{NH}_4^+] + [\text{H}_3\text{O}^+] = [\text{OH}^-]$$

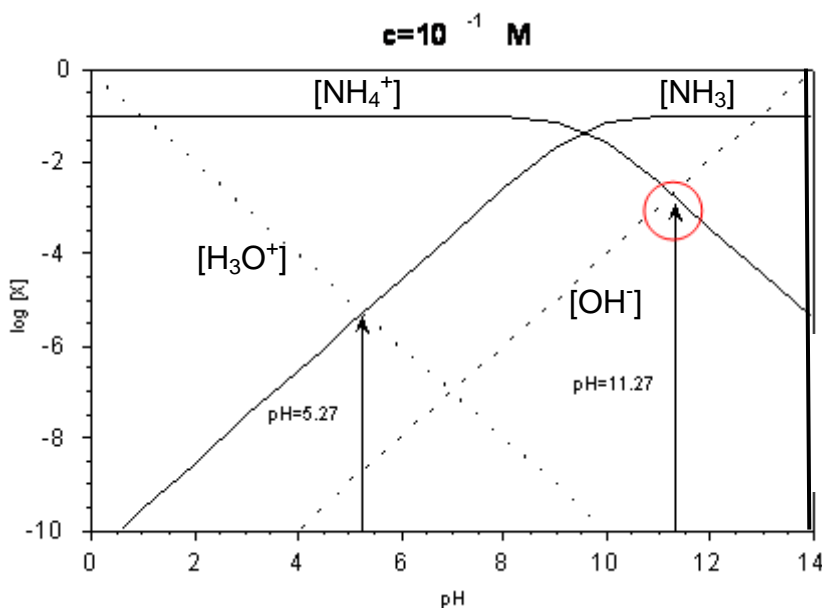
$$10^{-14} = [\text{H}_3\text{O}^+] [\text{OH}^-]$$

$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} \quad 4 \text{ ezezagun eta 4 ekuazio}$$

hurbilketa bat egingo dugu, diagraman oinarrituta:

protolito nagusia NH_3 denez, $[\text{H}_3\text{O}^+] < 10^{-7} \text{ M}$ eta $[\text{OH}^-] > 10^{-7} \text{ M}$; beraz,

$[\text{NH}_4^+]$ -arekin konparatuz $[\text{H}_3\text{O}^+]$ mesprezatu egingo dugu karga balantzean; horrela,



$$[\text{NH}_4^+] + [\text{H}_3\text{O}^+] = [\text{OH}^-] \Rightarrow [\text{NH}_4^+] \approx [\text{OH}^-] \text{ eta } c_{\text{NH}_3} \approx [\text{NH}_3]$$

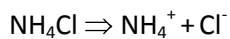
$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} = \frac{[\text{NH}_4^+][\text{OH}^-]}{c_{\text{NH}_3}} = \frac{[\text{OH}^-]^2}{c_{\text{NH}_3}}$$

$$[\text{OH}^-] = 10^{-2.73} \Rightarrow [\text{H}_3\text{O}^+] = 10^{-11.27} \Rightarrow \text{pH} = 11.27$$

[2] Kalkulatu ondoko disoluzioaren pHa:

$$c(\text{NH}_4\text{Cl}) = 0.1 \text{ M}, K_a(\text{NH}_4^+/\text{NH}_3) = 10^{-9.55}$$

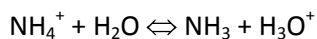
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NH_4^+ azido ahula da $K_a(\text{NH}_4^+/\text{NH}_3) = 10^{-9.55}$

Cl^- ez basea da, beraz, $c(\text{Cl}^-) = [\text{Cl}^-]$

Azido ahul batez osatutako sistema da



Masa-balantzea: $c(\text{Cl}^-) = [\text{Cl}^-] = c(\text{NH}_4^+) = 10^{-1} \text{ M} = [\text{NH}_4^+] + [\text{NH}_3]$

Karga-balantzea: $[\text{NH}_4^+] + [\text{H}_3\text{O}^+] = [\text{OH}^-] + [\text{Cl}^-]$

$$10^{-14} = [\text{H}_3\text{O}^+] [\text{OH}^-]$$

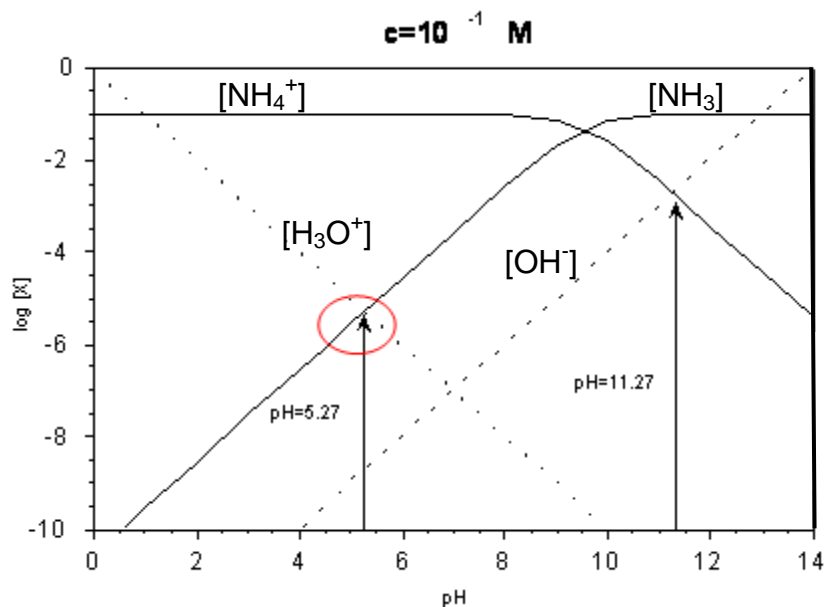
$$K_a = \frac{[\text{NH}_3][\text{H}_3\text{O}^+]}{[\text{NH}_4^+]} \quad 4 \text{ ezezagun eta 4 ekuazio}$$

Hurbilketa KBean: $[\text{OH}^-] \ll [\text{Cl}^-]$, beraz, $[\text{NH}_4^+] + [\text{H}_3\text{O}^+] \approx [\text{Cl}^-]$

MBarekin konparatuz $[\text{NH}_4^+] + [\text{NH}_3] = [\text{Cl}^-]$

Beraz, $[\text{H}_3\text{O}^+] \approx [\text{NH}_3]$ eta $c(\text{NH}_4^+) \approx [\text{NH}_4^+]$

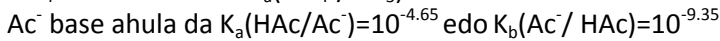
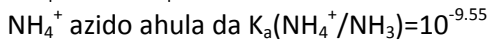
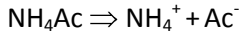
$$K_a = \frac{[\text{NH}_3][\text{H}_3\text{O}^+]}{[\text{NH}_4^+]} = \frac{[\text{H}_3\text{O}^+]^2}{c(\text{NH}_4^+)} \Rightarrow [\text{H}_3\text{O}^+] = 10^{-5.27} \Rightarrow \text{pH} = 5.27$$



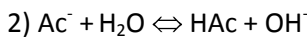
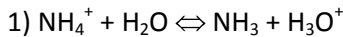
B. Azido eta baseak

[3] Kalkulatu ondoko disoluzioaren pHa:

$$c(\text{NH}_4\text{Ac}) = 0.1 \text{ M}, K_a(\text{NH}_4^+/\text{NH}_3) = 10^{-9.55}, K_b(\text{Ac}^-/\text{HAc}) = 10^{-9.35}$$

ERANTZUNA

Azido ahul batez eta base ahul batez osatutako sistema da.



Masa-balantzea:

$$c(\text{NH}_4^+) = 10^{-1} \text{ M} = [\text{NH}_4^+] + [\text{NH}_3]$$

$$c(\text{Ac}^-) = 10^{-1} \text{ M} = [\text{Ac}^-] + [\text{HAc}]$$

$$\text{Karga-balantzea: } [\text{NH}_4^+] + [\text{H}_3\text{O}^+] = [\text{OH}^-] + [\text{Ac}^-]$$

$$1. \text{ erreakzioaren arabera: } [\text{NH}_3] \approx [\text{H}_3\text{O}^+]_1 \quad K_a(\text{NH}_4^+/\text{NH}_3) = \frac{[\text{NH}_3][\text{H}_3\text{O}^+]_1}{[\text{NH}_4^+]} = \frac{([\text{H}_3\text{O}^+]_1)^2}{c(\text{NH}_4\text{Ac})}$$

$$2. \text{ erreakzioaren arabera: } [\text{HAc}] \approx [\text{OH}^-]_2 \quad K_b(\text{Ac}^-/\text{HAc}) = \frac{[\text{HAc}][\text{OH}^-]_2}{[\text{Ac}^-]} = \frac{([\text{OH}^-]_2)^2}{c(\text{Ac}^-)} = \frac{([\text{OH}^-]_2)^2}{c(\text{NH}_4\text{Ac})}$$

beraz, neutralizazioa: $\text{H}_3\text{O}^+ + \text{OH}^- \Rightarrow 2\text{H}_2\text{O}$

$[\text{H}_3\text{O}^+]_1 > [\text{OH}^-]_2$ baldin bada			$[\text{H}_3\text{O}^+]_1 < [\text{OH}^-]_2$ baldin bada		
espezia	H_3O^+	OH^-	espezia	H_3O^+	OH^-
hasieran	$[\text{H}_3\text{O}^+]_1$	$[\text{OH}^-]_2$	hasieran	$[\text{H}_3\text{O}^+]_1$	$[\text{OH}^-]_2$
amaieran	$[\text{H}_3\text{O}^+]_1 - [\text{OH}^-]_2$	-	amaieran	-	$[\text{OH}^-]_2 - [\text{H}_3\text{O}^+]_1$

$$[\text{H}_3\text{O}^+]_1 = \sqrt{c(\text{NH}_4\text{Ac}) \cdot K_a(\text{NH}_4^+/\text{NH}_3)}$$

$$[\text{OH}^-]_2 = \sqrt{c(\text{NH}_4\text{Ac}) \cdot K_b(\text{Ac}^-/\text{HAc})}$$

$$1) K_a(\text{NH}_4^+/\text{NH}_3) > K_b(\text{Ac}^-/\text{HAc}) \Rightarrow [\text{H}_3\text{O}^+]_1 > [\text{OH}^-]_2 \Rightarrow$$

$$\text{Orduan: } [\text{H}_3\text{O}^+] = [\text{H}_3\text{O}^+]_1 - [\text{OH}^-]_2$$

$$2) K_a(\text{NH}_4^+/\text{NH}_3) < K_b(\text{Ac}^-/\text{HAc}) \Rightarrow [\text{H}_3\text{O}^+]_1 < [\text{OH}^-]_2 \Rightarrow$$

$$[\text{OH}^-] = [\text{OH}^-]_2 - [\text{H}_3\text{O}^+]_1$$

Kasu honetan 2.aukera daukagu: $K_b(\text{Ac}^-/\text{HAc}) = 10^{-9.35} > K_a(\text{NH}_4^+/\text{NH}_3) = 10^{-9.55}$

$$[\text{H}_3\text{O}^+]_1 = (10^{-1} \cdot 10^{-9.55})^{1/2} = 10^{-5.275} \text{ eta } [\text{OH}^-]_2 = (10^{-1} \cdot 10^{-9.35})^{1/2} = 10^{-5.175}$$

$$\text{Beraz, } [\text{OH}^-] = 10^{-5.822} \Rightarrow [\text{H}_3\text{O}^+] = 10^{-8.178} \Rightarrow \text{pH} = 8.178$$

[4] Zenbat mL HCl 1M gehitu behar zaio ondoko disoluzioari, pH-a %5ean aldatzeko?

$$C_{\text{HAc}}=1 \text{ M eta } C_{\text{NaAc}}=1 \text{ M}$$

ERANTZUNA

Disoluzio indargetzailea da

$$[\text{H}_3\text{O}^+] = 10^{-4.65} \frac{c(\text{HAc})}{c(\text{Ac}^-)} = 10^{-4.65} \frac{1}{1} = 10^{-4.65} = 2.2387 \cdot 10^{-5}$$

HCl gehitzean, neutralizazioa: $\text{Ac}^- + \text{HCl} \Rightarrow \text{HAc} + \text{Cl}^-$

Beraz, $[\text{Ac}^-] \downarrow$, $[\text{HAc}] \uparrow \Rightarrow [\text{H}_3\text{O}^+] \uparrow$, $\text{pH} \downarrow$, $\Rightarrow \text{pH}_{\text{berria}} = 0.95 \text{pH}_{\text{zaharra}}$

$$\text{pH}_b = 0.95 \cdot 4.65 = 4.4175 \Rightarrow [\text{H}_3\text{O}^+] = 10^{-4.4175}$$

Litro bat	Ac^-	HCl	HAc
hasieran	1 mol	x mol	1 mol
amaieran	(1-x) mol	-	(1+x) mol

$$[\text{H}_3\text{O}^+]_{\text{berria}} = 10^{-4.65} \frac{c(\text{HAc})_{\text{amaiera}}}{c(\text{Ac}^-)_{\text{amaiera}}}$$

$$10^{-4.4175} = 10^{-4.65} \frac{1+x}{1-x} \Rightarrow \frac{10^{-4.4175}}{10^{-4.65}} (1-x) = (1+x) \Rightarrow$$

$$10^{0.2325} - 10^{0.2325} x = 1+x \Rightarrow 1 - 10^{0.2325} x = (1+10^{0.2325})x \Rightarrow$$

$$(10^{0.2325} = 0.5855)$$

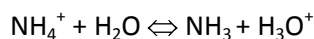
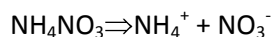
$$x = \frac{1 - 0.5855}{1 + 0.5855} = 0.2614 \text{ mol HCl} \Rightarrow v_{\text{HCl}} = \frac{0.2614 \text{ mol}}{1 \text{ M}} = 0.2628 \text{ L}$$

$$x = 263 \text{ mL}$$

[5] 1.5 M den amonio nitrato disoluzio baten pHa kalkulatu

$$K_a(\text{NH}_4^+/\text{NH}_3)=10^{-9.55}$$

ERANTZUNA



$$\text{MB: } c(\text{NH}_4\text{NO}_3) = c(\text{NH}_4^+) = c(\text{NO}_3^-) = [\text{NO}_3^-]$$

$$c(\text{NH}_4^+) = [\text{NH}_4^+] + [\text{NH}_3]$$

$$\text{KB: } [\text{NH}_4^+] + [\text{H}_3\text{O}^+] = [\text{NO}_3^-] + [\text{OH}^-]$$

$$\text{Hurbilketa: } [\text{OH}^-] \ll [\text{NO}_3^-] \text{ beraz, } \quad \text{KB: } [\text{NH}_4^+] + [\text{H}_3\text{O}^+] \approx [\text{NO}_3^-]$$

$$\text{MB: } [\text{NH}_4^+] + [\text{NH}_3] = [\text{NO}_3^-]$$

$$\text{Beraz, } [\text{H}_3\text{O}^+] \approx [\text{NH}_3] \text{ eta } c(\text{NH}_4^+) \approx [\text{NH}_4^+]$$

$$K_a = \frac{[\text{NH}_3][\text{H}_3\text{O}^+]}{[\text{NH}_4^+]} = \frac{[\text{H}_3\text{O}^+]^2}{c(\text{NH}_4^+)}$$

$$10^{-9.55} = \frac{[\text{H}_3\text{O}^+]^2}{1.5} \Rightarrow [\text{H}_3\text{O}^+] = 2.056 \cdot 10^{-5} = 10^{-4.69} \Rightarrow \text{pH} = 4.69$$

[6] 0.1 M den azido azetiko disoluzio baten 10 mL ditugu. Kalkulatu:

a) pHa

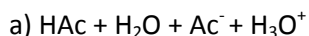
b) 0.1 M den NaOH disoluzio baten 6 ml gehitu ondoren dagoen pHa

c) 0.1 M den NaOH disoluzio beraren beste 4 ml gehitu ondoren dagoen pHa

d) 0.1 M den NaOH disoluzio beraren beste 15 ml gehitu ondoren dagoen pHa

$$\text{Datua: } K_a(\text{HAc}/\text{Ac}^-) = 10^{-4.65}$$

ERANTZUNA



$$\text{MB: } c(\text{HAc}) = [\text{HAc}] + [\text{Ac}^-]$$

$$\text{KB: } [\text{H}_3\text{O}^+] = [\text{Ac}^-] + [\text{OH}^-]$$

$$\text{Hurbilketa: } [\text{OH}^-] \ll [\text{Ac}^-] \text{ beraz, } \quad [\text{H}_3\text{O}^+] \approx [\text{Ac}^-] \text{ eta } c(\text{HAc}) \approx [\text{HAc}]$$

$$K_a = \frac{[\text{Ac}^-][\text{H}_3\text{O}^+]}{[\text{HAc}]} = \frac{[\text{H}_3\text{O}^+]^2}{c(\text{HAc})}$$

$$10^{-4.65} = \frac{[\text{H}_3\text{O}^+]^2}{0.1} \Rightarrow [\text{H}_3\text{O}^+] = 10^{-2.82} \Rightarrow \text{pH} = 2.82$$

b) 6 mL NaOH 0.1 M aurrekoari gehitzean, neutralizazioa



$$V_h(\text{HAc}) = 10 \text{ mL} \Rightarrow n(\text{HAc}) = 0.1 \text{ M} \times 10^{-2} \text{ L} = 1 \text{ mmol}$$

$$V_h(\text{NaOH}) = 6 \text{ mL} \Rightarrow n(\text{NaOH}) = 0.1 \text{ M} \times 6 \cdot 10^{-2} \text{ L} = 0.6 \text{ mmol}$$

$V_a = 16 \text{ mL}$	HAc	OH^-	Ac^-
hasieran	1 mmol	0.6 mol	-
amaieran	0.4 mmol	-	0.6 mmol

Beraz,

$$c(\text{HAc}) = \frac{0.4 \cdot 10^{-3} \text{ mol}}{0.016 \text{ L}} = 0.025 \text{ M}$$

Hau disoluzio indargetzaile bat da

$$c(\text{Ac}^-) = \frac{0.6 \cdot 10^{-3} \text{ mol}}{0.016 \text{ L}} = 0.0375 \text{ M}$$

$$\text{Beraz, } [\text{H}_3\text{O}^+] = 10^{-4.65} \frac{c(\text{HAc})}{c(\text{Ac}^-)} = 10^{-4.65} \frac{0.025}{0.0375} = 10^{-4.83}$$

pH=4.83

c) 4 ml NaOH 0.1 M gehitzean, $\text{HAc} + \text{NaOH} \Rightarrow \text{NaAc} + \text{H}_2\text{O}$ edo $\text{HAc} + \text{OH}^- \Rightarrow \text{Ac}^- + \text{H}_2\text{O}$

Disoluzioaren pHa ez da asko aldatu behar aurrekoa indargetzailea zen eta.

$$V_h(\text{NaOH}) = 4 \text{ ml} \Rightarrow n(\text{NaOH}) = 0.1 \text{ M} \times 4 \cdot 10^{-2} \text{ l} = 0.4 \text{ mmol}$$

$V_a = 20 \text{ ml}$	HAc	OH^-	Ac^-
hasieran	0.4 mmol	0.4 mmol	0.6 mmol
amaieran	-	-	10 mmol

$$\text{Orain, } c(\text{Ac}^-) = \frac{10 \cdot 10^{-3} \text{ mol}}{0.020 \text{ L}} = 0.05 \text{ M}$$

$$c(\text{Na}^+) = \frac{(6 + 4) \cdot 10^{-3} \text{ mol}}{0.020 \text{ L}} = 0.05 \text{ M}$$

$$K_b(\text{Ac}^- / \text{HAc}) = 10^{-9.35}$$

$$\text{MB: } c(\text{NaAc}) = c(\text{Na}^+) = c(\text{Ac}^-) = [\text{HAc}] + [\text{Ac}^-] \text{ eta } \text{KB: } : [\text{Na}^+] + [\text{H}_3\text{O}^+] = [\text{Ac}^-] + [\text{OH}^-]$$

Hurbilketa: $[\text{Na}^+] \gg [\text{H}_3\text{O}^+]$ beraz, $[\text{OH}^-] \approx [\text{HAc}]$ eta $c(\text{Ac}^-) \approx [\text{HAc}]$

$$K_b(\text{Ac}^- / \text{HAc}) = \frac{[\text{HAc}][\text{OH}^-]}{[\text{Ac}^-]} = \frac{[\text{OH}^-]^2}{c(\text{Ac}^-)}$$

$$10^{-9.35} = \frac{[\text{OH}^-]^2}{0.05} \Rightarrow [\text{OH}^-] = 10^{-5.32}$$

$$\Rightarrow [\text{H}_3\text{O}^+] = 10^{-8.68} \Rightarrow \text{pH} = 8.68$$

d) 15 mL NaOH 0.1 M aurrekoari gehitzean, bi basez osutako sistema daukagu

NaOH sendoa denez, $\text{NaOH} \Rightarrow \text{Na}^+ + \text{OH}^-$

beraz, $n(\text{OH}^-)_{\text{berria}} = n(\text{OH}^-)_{\text{zaharra}} + n(\text{OH}^-)_{\text{gehitutakoa}}$

$$[\text{OH}^-]_{\text{berria}} = \frac{((10^{-5.32} \text{ M} \times 20 \cdot 10^{-3} \text{ L}) + (0.1 \text{ M} \times 15 \cdot 10^{-3} \text{ L})) \text{ mol}}{(20 + 15) \cdot 10^{-3} \text{ L}}$$

$$[\text{OH}^-]_{\text{berria}} \approx \frac{(0.1 \text{ M} \times 15 \cdot 10^{-3} \text{ L}) \text{ mol}}{(20 + 15) \cdot 10^{-3} \text{ L}} = 10^{-1.37} \text{ M}$$

beraz, $[\text{H}_3\text{O}^+] = 10^{-12.63} \Rightarrow \text{pH} = 12.63$

[7] 1 mol NH_4Cl eta 1 mol NH_4OH (edo NH_3) dituen disoluzio baten litro bat daukagu.

Kalkulatu:

a) pHa

b) 0.10 mol NaOH solido gehitu ondoren dagoen pHa

c) 0.10 mol NaOH solido ur puruaren litro batean disolbatuz gero dagoen pHa

d) 0.10 mol HCl solido gehitu ondoren dagoen pHa

e) 0.10 mol HCl solido ur puruaren litro batean disolbatuz gero dagoen pHa

Datua: $K_a(\text{NH}_4^+/\text{NH}_3) = 10^{-9.55}$

ERANTZUNA

a) Disoluzio indargetzailea da $[\text{H}_3\text{O}^+] = 10^{-9.55} \frac{c(\text{NH}_4^+)}{c(\text{NH}_3)} = 10^{-9.55} \frac{1}{1} = 10^{-9.55}$
 $\text{pH} = 9.55$

b) 0.10 mol NaOH gehitu ondoren

$\text{NH}_4\text{Cl} + \text{NaOH} \Rightarrow \text{NH}_4\text{OH} + \text{NaCl}$ edo $\text{NH}_4^+ + \text{OH}^- \Rightarrow \text{NH}_3 + \text{H}_2\text{O}$

$V_a = 1 \text{ L}$	NH_4^+	OH^-	NH_3
hasieran	1 mol	0.1 mol	1 mol
amaieran	0.9	-	1.1 mol

$$[\text{H}_3\text{O}^+] = 10^{-9.55} \frac{c(\text{NH}_4^+)}{c(\text{NH}_3)} = 10^{-9.55} \frac{0.9}{1.1} = 10^{-9.64}$$

$\text{pH} = 9.64$

c) 0.1 mol NaOH, 1l

NaOH sendoa denez, $\text{NaOH} \Rightarrow \text{Na}^+ + \text{OH}^-$

Beraz, $[\text{OH}^-] = c(\text{NaOH}) = 10^{-1} \text{ M} \Rightarrow [\text{H}_3\text{O}^+] = 10^{-13} \text{ M} \Rightarrow \text{pH} = 13$

d) 0.10 mol HCl gehitu ondoren

$\text{NH}_4\text{OH} + \text{HCl} \Rightarrow \text{NH}_4\text{Cl} + \text{H}_2\text{O}$ edo $\text{NH}_3 + \text{H}_3\text{O}^+ \Rightarrow \text{NH}_4^+ + \text{H}_2\text{O}$

$V_a = 1 \text{ L}$	NH_3	H_3O^+	NH_4^+
hasieran	1 mol	0.1 mol	1 mol
amaieran	0.9 mol	-	1.1 mol

$$[\text{H}_3\text{O}^+] = 10^{-9.55} \frac{c(\text{NH}_4^+)}{c(\text{NH}_3)} = 10^{-9.55} \frac{1.1}{0.9} = 10^{-9.46}$$

pH = 9.46

e) 0.1 mol HCl, 1L

HCl sendoa denez, $\text{HCl} \Rightarrow \text{H}^+ + \text{Cl}^-$ edo $\text{HCl} + \text{H}_2\text{O} \Rightarrow \text{H}_3\text{O}^+ + \text{Cl}^-$

Beraz, $[\text{H}_3\text{O}^+] = c(\text{HCl}) = 10^{-1} \text{ M} \Rightarrow \text{pH} = 1$

[8] 0.1 M den NH_4Cl eta 0.1 M den NH_4OH dauzkagu disolbatuta.

a) Disoluzio horren 100 mL eta 0.1 M den NH_4OH daukan bigarren disoluzio baten 100 mL nahastuz gero, zein da pHa?

b) lehen disoluzioaren 100 mL-ko bolumen bati, ur puru 100 mL gehitzen bazaizkio, zein da pHa?

c) lehen disoluzioaren 100 mL-ko bolumen bati, ur puru 100 mL eta HCl 100 ml gehitzen bazaizkio, zein da pHa?

Datua: $K_a(\text{NH}_4^+/\text{NH}_3) = 10^{-9.55}$

ERANTZUNA

a) $n(\text{NH}_4\text{Cl})_{\text{zegoena}} = 0.1 \text{ M} \times 0.1 \text{ L} = 0.01 \text{ mol}$

$n(\text{NH}_4\text{OH})_{\text{zegoena}} = n(\text{NH}_3) = 0.1 \text{ M} \times 0.1 \text{ L} = 0.01 \text{ mol}$

$n(\text{NH}_4\text{OH})_{\text{gehituta}} = n(\text{NH}_3) = 0.1 \text{ M} \times 0.1 \text{ L} = 0.01 \text{ mol}$

Base bat gehitu denez, neutralizazioa gertatuko da

$\text{NH}_4^+ + \text{NH}_3 \Rightarrow \text{NH}_3 + \text{NH}_4^+$

V=200 ml	NH ₄ ⁺ zegoena	NH ₃ gehituta	NH ₃ zegoena	NH ₄ ⁺
hasieran	0.01 mol	0.01 mol	0.01 mol	
amaieran	-	-	0.02 mol	0.01 mol

Beraz,

$$[\text{H}_3\text{O}^+] = 10^{-9.55} \frac{c(\text{NH}_4^+)}{c(\text{NH}_3)} = 10^{-9.55} \frac{0.01/V}{0.02/V} = 10^{-9.85}$$

pH = 9.85

b) 100 mL ur gehitzean

$$n(\text{NH}_4\text{Cl}) = 0.1\text{M} \times 0.1\text{ L} = 0.01\text{ mol}$$

$$n(\text{NH}_3) = n(\text{NH}_3) = 0.1\text{M} \times 0.1\text{ L} = 0.01\text{ mol}$$

$$c(\text{NH}_4^+)_2 = \frac{n(\text{NH}_4^+)}{V_2} = \frac{0.01\text{ mol}}{0.2\text{ L}} = 0.05 = \frac{c(\text{NH}_4^+)_1}{2}$$

$$c(\text{NH}_3)_2 = \frac{n(\text{NH}_3)}{V_2} = \frac{0.01\text{ mol}}{0.2\text{ L}} = 0.05 = \frac{c(\text{NH}_3)_1}{2}$$

Beraz,

$$[\text{H}_3\text{O}^+] = 10^{-9.55} \frac{c(\text{NH}_4^+)}{c(\text{NH}_3)} = 10^{-9.55} \frac{0.05}{0.05} = 10^{-9.55}$$

pH = 9.55

c) Ur puru (100 mL) + HCl (0.1 M, 100 mL) gehitzean

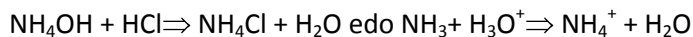
$$V_0 = 0.1\text{ L} + 0.1\text{ L} + 0.1\text{ L} = 0.3\text{ L}$$

$$n(\text{NH}_4\text{Cl}) = 0.1\text{ M} \times 0.1\text{ L} = 0.01\text{ mol}$$

$$n(\text{NH}_3) = n(\text{NH}_3) = 0.1\text{ M} \times 0.1\text{ L} = 0.01\text{ mol}$$

$$n(\text{HCl}) = 0.1\text{ M} \times 0.1\text{ L} = 0.01\text{ mol}$$

Azido bat gehitzean, neutralizazioa



V _a =0.3 L	NH ₃	H ₃ O ⁺	NH ₄ ⁺
hasieran	0.01 mol	0.01 mol	0.01 mol
amaieran	-	-	0.02 mol

Beraz,

$$c(\text{NH}_4^+) = \frac{n(\text{NH}_4^+)}{V_0} = \frac{0.02\text{ mol}}{0.3\text{ L}} = 0.067\text{ M}$$

$$c(\text{Cl}^-) = \frac{n(\text{NH}_4\text{Cl}) + n(\text{HCl})}{V_0} = \frac{0.01\text{ mol} + 0.01\text{ mol}}{0.3\text{ L}} = 0.067\text{ M}$$

$$\text{MB: } c(\text{NH}_4\text{Cl}) = c(\text{NH}_4^+) = c(\text{Cl}^-) = [\text{Cl}^-]$$

$$c(\text{NH}_4^+) = [\text{NH}_4^+] + [\text{NH}_3]$$

$$\text{KB: } [\text{NH}_4^+] + [\text{H}_3\text{O}^+] = [\text{Cl}^-] + [\text{OH}^-]$$

$$\text{Hurbilketa: } [\text{OH}^-] \ll [\text{Cl}^-] \text{ beraz, KB: } [\text{NH}_4^+] + [\text{H}_3\text{O}^+] \approx [\text{Cl}^-]$$

$$\text{MB: } [\text{NH}_4^+] + [\text{NH}_3] = [\text{Cl}^-]$$

$$\text{Beraz, } [\text{H}_3\text{O}^+] \approx [\text{NH}_3] \text{ eta } c(\text{NH}_4^+) \approx [\text{NH}_4^+]$$

$$K_a = \frac{[\text{NH}_3][\text{H}_3\text{O}^+]}{[\text{NH}_4^+]} = \frac{[\text{H}_3\text{O}^+]^2}{c(\text{NH}_4^+)}$$

$$10^{-9.55} = \frac{[\text{H}_3\text{O}^+]^2}{0.67} \Rightarrow [\text{H}_3\text{O}^+] = 10^{-5.36} \Rightarrow \text{pH} = 5.36$$

[9] A, B eta C ontziak ditugu.

A ontzian 300 ml HCN 0.1 M daude

B ontzian 200 ml KOH 0.15 M daude

C ontzian 100 ml HCl 0.15 M

Ondokoa kalkulatu:

a) A ontziko disoluzioaren pHa

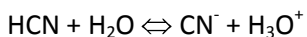
b) A eta B ontziko disoluzioak nahastuz gero lortzen den disoluzio berriaren pHa

c) A, B eta C ontziko disoluzioak nahastuz gero lortzen den disoluzio berriaren pHa

$$\text{Datua: } K_a(\text{HCN}/\text{CN}^-) = 10^{-9.1}$$

ERANTZUNA

a) Azido ahul batez osatutako sistema da



$$\text{Masa-balantzea: } c(\text{HCN}) = 0.15 \text{ M} = [\text{HCN}] + [\text{CN}^-]$$

$$\text{Karga-balantzea: } [\text{H}_3\text{O}^+] = [\text{OH}^-] + [\text{CN}^-]$$

$$\text{Hurbilketa KBean: } [\text{OH}^-] \ll [\text{CN}^-], \text{ beraz, } [\text{H}_3\text{O}^+] \approx [\text{CN}^-] \text{ eta } c(\text{HCN}) \approx [\text{HCN}]$$

$$K_a = \frac{[\text{CN}^-][\text{H}_3\text{O}^+]}{[\text{HCN}]} = \frac{[\text{H}_3\text{O}^+]^2}{c(\text{HCN})}$$

$$10^{-9.1} = \frac{[\text{H}_3\text{O}^+]^2}{0.15} \Rightarrow [\text{H}_3\text{O}^+] = 10^{-4.96} \Rightarrow \text{pH} = 4.96$$

b) $V_A + V_B = 500 \text{ ml}$

KOH gehitzean, neutralizazioa $\text{HCN} + \text{KOH} \Rightarrow \text{KCN} + \text{H}_2\text{O}$ edo $\text{HCN} + \text{OH}^- \Rightarrow \text{CN}^- + \text{H}_2\text{O}$

$$n(\text{HCN}) = 0.1 \text{ M} \times 0.3 \text{ l} = 0.03 \text{ mol}$$

$$n(\text{KOH}) = 0.15 \text{ M} \times 0.2 \text{ l} = 0.03 \text{ mol}$$

$V_a = 0.5 \text{ l}$	HCN	OH^-	CN^-
hasieran	0.03 mol	0.03 mol	-
amaieran	-	-	0.03 mol

Beraz,

$$c(\text{CN}^-) = \frac{n(\text{CN}^-)}{V_o} = \frac{0.03 \text{ mol}}{0.5 \text{ L}} = 0.06 \text{ M}$$

$$c(\text{K}^+) = \frac{n(\text{K}^+)}{V_o} = \frac{0.03 \text{ mol}}{0.5 \text{ L}} = 0.06 \text{ M}$$

MB: $c(\text{KCN}) = c(\text{K}^+) = [\text{K}^+] = c(\text{CN}^-)$

$$c(\text{CN}^-) = [\text{HCN}] + [\text{CN}^-]$$

KB: $[\text{K}^+] + [\text{H}_3\text{O}^+] = [\text{CN}^-] + [\text{OH}^-]$

Hurbilketa: $[\text{K}^+] \gg [\text{H}_3\text{O}^+]$ beraz, KB: $[\text{K}^+] \approx [\text{CN}^-] + [\text{OH}^-]$

$$\text{MB: } c(\text{CN}^-) = [\text{K}^+] = [\text{HCN}] + [\text{CN}^-]$$

Beraz, $[\text{HCN}] \approx [\text{OH}^-]$ eta $c(\text{CN}^-) \approx [\text{CN}^-]$

$$K_a = 10^{-9.1} \Rightarrow K_b = 10^{-4.9} = \frac{[\text{HCN}][\text{OH}^-]}{[\text{CN}^-]} = \frac{[\text{OH}^-]^2}{c(\text{CN}^-)}$$

$$10^{-4.9} = \frac{[\text{OH}^-]^2}{0.06} \Rightarrow [\text{OH}^-] = 10^{-3.06} \Rightarrow [\text{H}_3\text{O}^+] = 10^{-10.94} \Rightarrow \text{pH} = 10.94$$

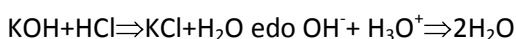
c) $V_A + V_B + V_C = 600 \text{ mL}$

$$n(\text{HCN}) = 0.1 \text{ M} \times 0.3 \text{ L} = 0.03 \text{ mol}$$

$$n(\text{KOH}) = 0.15 \text{ M} \times 0.2 \text{ L} = 0.03 \text{ mol}$$

$$n(\text{HCl}) = 0.15 \text{ M} \times 0.1 \text{ L} = 0.015 \text{ mol}$$

1. Lehenbizi azido eta base sendoen neutralizazioa:



$V_a = 0.6 \text{ L}$	HCl	KOH	KCl
hasieran	0.015 mol	0.03 mol	-
amaieran	-	0.015 mol	0.015 mol

2. KOH soberan dagoenez, HCN neutralizatuko du



$V_a = 0.6 \text{ L}$	HCN	OH^-	CN^-
hasieran	0.03 mol	0.015 mol	-
amaieran	0.015 mol	-	0.015 mol

OHAR: 1 eta 2 pausuak batera eginez...



$V_a = 0.6 \text{ L}$	KOH	HCl	HCN	CN^-
hasieran	0.03 mol	0.015 mol	0.03 mol	-
amaieran	-	-	0.015 mol	0.015 mol

Beraz, disoluzio indargetzailea geratzen da.

$$c(\text{HCN}) = \frac{n(\text{HCN})}{V_o} = \frac{0.015 \text{ mol}}{0.6 \text{ L}} = 0.025 \text{ M}$$

$$c(\text{CN}^-) = \frac{n(\text{CN}^-)}{V_o} = \frac{0.015 \text{ mol}}{0.6 \text{ L}} = 0.025 \text{ M}$$

Beraz,

$$[\text{H}_3\text{O}^+] = 10^{-9.1} \frac{c(\text{HCN})}{c(\text{CN}^-)} = 10^{-9.1} \frac{0.025}{0.025} = 10^{-9.1}$$

$$\text{pH} = 9.1$$

[10] A eta B disoluzioak ditugu: A disoluzioa 0.25 g NaOH 500 mL uretan disolbatuz lortu da eta B disoluzioa 300 mL HClO 10^{-2} M da.

A disoluziotik 40 mL eta B disoluziotik 125 mL hartzen dira eta 250 mL-tan diluitzen dira. Zein da pHa?

$$\text{Datuak: } K_a(\text{HClO}/\text{ClO}^-) = 10^{-7.52}$$

$$P_m(\text{NaOH}) = 40 \text{ g} \cdot \text{mol}^{-1}$$

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$$c(\text{NaOH})_A = \frac{n(\text{NaOH})}{V_A} = \frac{0.25 \text{ g} / 40 \text{ g} \cdot \text{mol}^{-1}}{0.5 \text{ L}} = 0.0125 \text{ M}$$

$$c(\text{HClO})_B = 0.01 \text{ M}$$

$$c(\text{NaOH})_C = \frac{n(\text{NaOH})}{V_C} = \frac{0.0125 \text{ M} \times 0.04 \text{ L}}{0.25 \text{ L}} = \frac{0.5 \text{ mmol}}{0.25 \text{ L}} = 0.002 \text{ M}$$

$$c(\text{HClO})_C = \frac{n(\text{HClO})}{V_C} = \frac{0.01 \text{ M} \times 0.125 \text{ L}}{0.25 \text{ L}} = \frac{1.25 \text{ mmol}}{0.25 \text{ L}} = 0.005 \text{ M}$$

Neutralizazioa $\text{NaOH} + \text{HClO} \Rightarrow \text{NaClO} + \text{H}_2\text{O}$ edo $\text{OH}^- + \text{HClO} \Rightarrow \text{ClO}^- + \text{H}_2\text{O}$

$V_a=0.25 \text{ L}$	OH^-	HClO	ClO^-
hasieran	0.5 mmol	1.25 mmol	-
amaieran	-	0.75 mmol	0.5 mmol

Beraz, disoluzio indargetzailea daukagu

$$[\text{H}_3\text{O}^+] = 10^{-7.52} \frac{c(\text{HClO})}{c(\text{ClO}^-)} = 10^{-7.52} \frac{0.75 \cdot 10^{-3} / V}{0.5 \cdot 10^{-3} / V} = 10^{-7.34}$$

$$\text{pH} = 7.34$$

[11]Hurrengo disoluzioak indargetzaileak izango al dira?

- a) NaCl (50 mL, 10^{-3} M) + HCl (50 mL, 10^{-3} M)
- b) NaCl (50 mL, 10^{-3} M) + HCl (50 mL, 1 M)
- c) HCl (50 mL, 1 M)
- d) NaOH (50 mL, 10^{-3} M) + HAc (100 mL, 10^{-3} M)
- e) NaOH (100 mL, 10^{-3} M) + HAc (100 mL, 10^{-3} M)

ERANTZUNA

a, b eta c ez dira indargetzaileak HA/A^- bikote konjokatu ahula behar-beharrezkoa baita

d) $n(\text{NaOH}) = 0.05 \text{ L} \times 10^{-3} \text{ M} = 0.05 \text{ mmol}$

$$n(\text{HAc}) = 0.1 \text{ L} \times 10^{-3} \text{ M} = 0.01 \text{ mmol}$$

Beraz, $\text{NaOH} + \text{HAc} \Rightarrow \text{NaAc} + \text{H}_2\text{O}$

$V_a=0.150 \text{ L}$	NaOH	HAc	NaAc
hasieran	0.05 mmol	0.01 mmol	-
amaieran	0.04 mmol	-	0.01 mmol

Base ahul batez eta base sendo batez osatutako sistema da hau. Beraz, ez da indargetzailea

e) d) $n(\text{NaOH}) = 0.1 \text{ L} \times 10^{-3} \text{ M} = 0.01 \text{ mmol}$

$$n(\text{HAc}) = 0.1 \text{ L} \times 10^{-3} \text{ M} = 0.01 \text{ mmol}$$

Beraz, $\text{NaOH} + \text{HAc} \Rightarrow \text{NaAc} + \text{H}_2\text{O}$

B. Azido eta baseak

$V_a=0.200\text{ L}$	NaOH	HAc	NaAc
hasieran	0.01 mmol	0.01 mmol	-
amaieran	-	-	0.01 mmol

Base ahul batez osatutako sistema da hau. Beraz, ez da indargetzailea

[12]pH=9.8 duen disoluzio indargetzaile baten litro bat prestatu bahi dugu eta eskuragarri dauzkagun errektiboak ondokoak dira: NH_3 , HCl, NaCl, HAc eta NaOH. Guztien kontzentrazioa 0.1 M da. Nola presta daiteke disoluzioa?

Datuak: $K_a(\text{NH}_4^+/\text{NH}_3)=10^{-9.55}$ eta $K_a(\text{HAc}/\text{Ac}^-)=10^{-4.65}$

ERANTZUNA

$\text{NH}_4^+/\text{NH}_3$ bikotea aukeratu behar da disoluzioaren pHa bere azidotasunaren konstantetik gertu baitago

$$[\text{H}_3\text{O}^+] = K_a \frac{c(\text{NH}_4^+)}{c(\text{NH}_3)} = 10^{-9.8} = 10^{-9.55} \frac{c(\text{NH}_4^+)}{c(\text{NH}_3)}$$

$$\Rightarrow \frac{c(\text{NH}_4^+)}{c(\text{NH}_3)} = \frac{10^{-9.8}}{10^{-9.55}} = 10^{-0.25} = 0.56$$

NH_4^+ lortzeko ondoko erreakzioa egin beharko dugu:



$V_a=1\text{ L}$	NH_3	HCl	NH_4Cl
hasieran	x	y	-
amaieran	x-y	-	y

$$\frac{c(\text{NH}_4^+)}{c(\text{NH}_3)} = \frac{n(\text{NH}_4^+)/V}{n(\text{NH}_3)/V} = 0.56 = \frac{y}{x-y}$$

$$\text{beraz, } 0.56(x-y) = y \Rightarrow 0.56x - 0.56y = y \Rightarrow 0.56x = 1.56y$$

$$y = 0.359x$$

$$x = 0.1 \text{ M} \cdot V_{\text{NH}_3}$$

$$y = 0.1 \text{ M} \cdot V_{\text{HCl}}$$

$$V_a = V_{\text{NH}_3} + V_{\text{HCl}} = 1 \text{ L}$$

$$\text{beraz, } y = 0.1 \text{ M} \cdot (1 - V_{\text{NH}_3}) = 0.359x = 0.359 \cdot 0.1 \text{ M} \cdot V_{\text{NH}_3}$$

$$0.1 - 0.1V_{\text{NH}_3} = 0.0359V_{\text{NH}_3} \Rightarrow 0.1 = 0.1359V_{\text{NH}_3}$$

$$V_{\text{NH}_3} = 0.736 \text{ L} \Rightarrow V_{\text{HCl}} = 1 - V_{\text{NH}_3} = (1 - 0.736) \text{ L} = 0.264 \text{ L}$$

[13] Zenbat gramo NaOH disolbatu behar ditugu 3M den HAc disoluzio baten 200 mL-tan, 500 mL-tara diluituz gero disoluzioaren pH=4.1 izan dadin?

Datua: $K_a(\text{HAc}/\text{Ac}^-) = 10^{-4.65}$

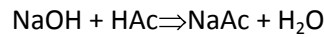
ERANTZUNA

$\text{p}K_a - 1 < 4.1 < \text{p}K_a + 1$, beraz disoluzio indargetzaile bat prestatu behar da

$$[\text{H}_3\text{O}^+] = K_a \frac{c(\text{HAc})}{c(\text{Ac}^-)} = 10^{-4.1} = 10^{-4.65} \frac{c(\text{HAc})}{c(\text{Ac}^-)}$$

$$\frac{c(\text{HAc})}{c(\text{Ac}^-)} = 10^{0.55} = 3.55$$

NaOH gehitzean, neutralazioa



$V_a = 0.5 \text{ L}$	NaOH	HAc	NaAc
hasieran	x	y	-
amaieran	-	y-x	x

$$\frac{c(\text{HAc})}{c(\text{Ac}^-)} = 3.55 = \frac{(y-x)/V}{x/V} = \frac{y-x}{x}$$

$$3.55x = y - x \Rightarrow y = 4.55x$$

$$x = \frac{m(\text{NaOH})}{P_m(\text{NaOH})}$$

$$y = 3 \text{ M} \cdot 0.2 \text{ L} = 0.6 \text{ mol}$$

$$x = \frac{0.6 \text{ mol}}{4.55} = 0.132 \text{ mol}$$

$$m(\text{NaOH}) = x \cdot P_m(\text{NaOH}) = 0.132 \text{ mol} \cdot 40 \text{ g} \cdot \text{mol}^{-1} = 5.28 \text{ g}$$

[14]Metilo gorria indikatzailearen espezie gorria ez dago ionizatua eta horia, bai. Espezie gorriaren %6a eta horiaren %12a (ehuneko molarra) ezin badira ikusi, zein da indikatzaile horren pH-tartea?

Datua: $K_a(\text{HIn}/\text{In}^-)=10^{-5.1}$

ERANTZUNA

Datuen arabera: HIn espeziea gorria da; eta In⁻ delakoa, horia. Demagun $c_{\text{osoa}}=1 \text{ M}$.

	[HIn]	[In ⁻]
pH > pK_a	0.06	0.94
pH < pK_a	0.88	0.12

$$[\text{H}_3\text{O}^+] = K_a \frac{[\text{HIn}]}{[\text{In}^-]} = 10^{-5.1} \frac{0.06}{0.94} = 10^{-6.29}$$

$$[\text{H}_3\text{O}^+] = K_a \frac{[\text{HIn}]}{[\text{In}^-]} = 10^{-5.1} \frac{0.88}{0.12} = 10^{-4.23}$$

$$4.23 < \text{pH} < 6.29$$