Clase 11 29 Abril 2022

Título de la nota 29/04/2022

Complejos solubles

Instrucción: llene los valores en las celdas de color amarillo

En las celdas de color verde aparecen los resultados

Catión	[] (mol/L)	pH=	12.00
Ca+2	0.010000		

Complejo	LOG K_{ML}
Ca-AEDTA	10.70
	K_{ML}
	5.0119e+10

Indicador	LOG K_{ML}
Calmagita	6.10
	K_F
	1.2589e+6

Ligante	pk_1	pka_2	pka_3	pka_4	pka_5	pka_6
AEDTA	0.00	1.50	2.00	2.65	6.25	10.35

	β1	β2	β3	β4	β5	β6
AEDTA	2.2387e+10	3.9811e+16	1.7783e+19	1.7783e+21	5.6234e+22	5.6234e+22
Ca(OH)	1.9953e+1	1.0000e+0	1.0000e+0	1.0000e+0	1.0000e+0	1.0000e+0
LOG	1.30	0.00	0.00	0.00	0.00	0.00

Indicador	pKa_1	pKa_2	pKa_3	pKa_4	pKa_5
Calmagita	8.10	12.40	-34.00	-30.00	-20.00

Nota: Si el indicador es un diácido llenar las celdas con el valor de pka1 y pka2 respectivamente, en las demás celdas introducir valores negativos

pH de inicio de precipitación

	pKs
Ca(OH)2	5.30

Ca(OH)2	↔	Ca+2	2OH-

pH	12.35

Ks=	[Ca+2]	[OH]2	=	5.0119e-6		
[OH-]2	=	Ks	=	5.0119e-6	=	5.0119e-4
		[Ca+2]		0.01		

[OH]	=	0.0224

K'_{ML}=	5.0119e+10	=	4.0864e+10	
	1.2265e+0		LOG	= 10.61

Ɛ=	4.9469e-5	
%Q=	99.9951	CUANTITATIVO

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Complejo	LOG K_{ML}
Ca-AEDTA	10.70

pH 12

$$Ca^{+2} + y^{-4} \rightleftharpoons [(Cay)^{-2}]$$

$$K'_{Cay} = \frac{K_{Cay}}{\alpha_{Ca(OH)}\ \alpha_{y(H_3O^+)}}$$

$$= \frac{10^{10.7}}{10^{0.009}\ 10^{0.08}} = \frac{10^{10.7}}{10^{0.089}}$$

$$\alpha_{Ca(OH)} = 1 + \beta [OH^-]$$

$$[OH^-] = 10^{-2}$$

$$= 1 + 10^{1.3} [10^{-2}]$$

$$= 1 + 10^{-0.7}$$

$$= 1.1995 = 10^{0.08}$$

pH = 12

$$\alpha_{Y(H_3O^+)} = 1 + \beta_{P1}[H_3O^+] + \beta_{P2}[H_3O^+]^2 + \beta_{P3}[H_3O^+]^3 + \beta_{P4}[H_3O^+]^4 + \beta_{P5}[H_3O^+]^5 + \beta_{P6}[H_3O^+]^6$$

$$= 1 + 10^{10.35}[10^{-12}] + 10^{16.6}[10^{-12}]^2 + 10^{19.25}[10^{-12}]^3 + 10^{21.25}[10^{-12}]^4 + 10^{22.75}[10^{-12}]^5 + 10^{22.75}[10^{-12}]^6$$

$$= 1 + 10^{-1.65} + 10^{-7.4} + 10^{-16.75} + 10^{-26.75} + 10^{-37.25} + 10^{-49.25}$$

$$= 10^{0.009}$$

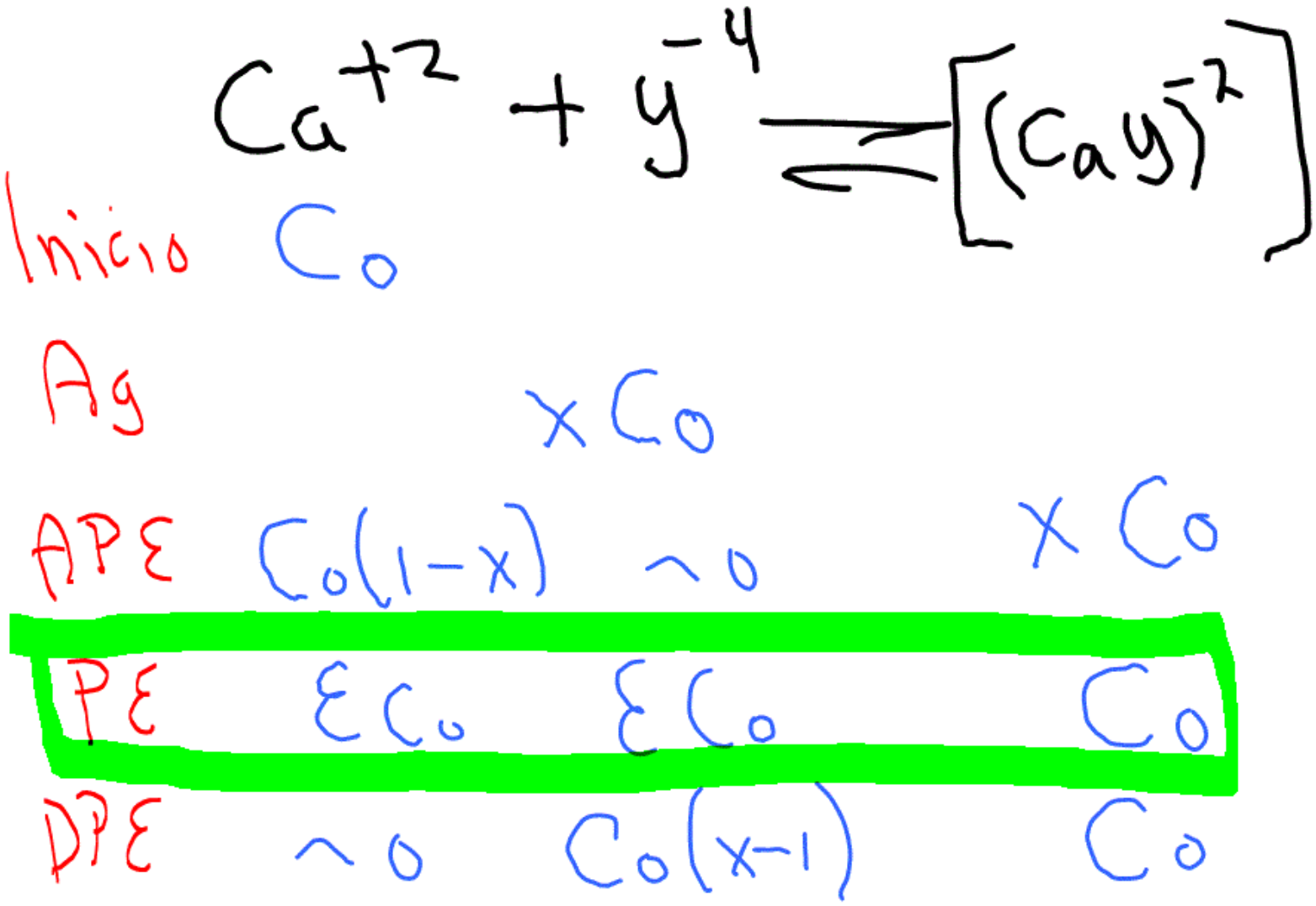
$$K'_{CaY} = \frac{K_{CaY}}{\alpha_{Ca(OH)}\,\alpha_{Y(H_3O^+)}}$$

$$= \frac{10^{10.7}}{10^{0.009}\;10^{0.08}} = \frac{10^{10.7}}{10^{0.089}}$$

$$= 10^{10.611}$$

K'_{MI}=	5.0119e+10 / 1.2265e+0	=	4.0864e+10		
			LOG	=	10.61

ε=	4.9469e-5	
%Q=	99.9951	CUANTITATIVO


$Ca^{+2} + y^{-4} \rightleftharpoons [(Ca\,y)^{-2}]$
Inicio C_0
Ag xC_0
APE $C_0(1-x)$ ~ 0 xC_0
PE ξC_0 ξC_0 C_0
DPE ~ 0 $C_0(x-1)$ C_0

$$K_F' = 10^{10.61} = \frac{[(aY)^{-2}]}{[Ca^{+2}][Y^{-4}]}$$

$$10^{10.61} = \frac{C_0}{\varepsilon C_0 \varepsilon C_0}$$

$$\varepsilon^2 = \frac{1}{K_F' C_0}$$

$$\varepsilon = \sqrt{\frac{1}{K_F' C_0}} \qquad C_0 = 10^{-2}\ M$$

$$= \sqrt{\frac{1}{10^{10.61} \cdot 10^{-2}}}$$

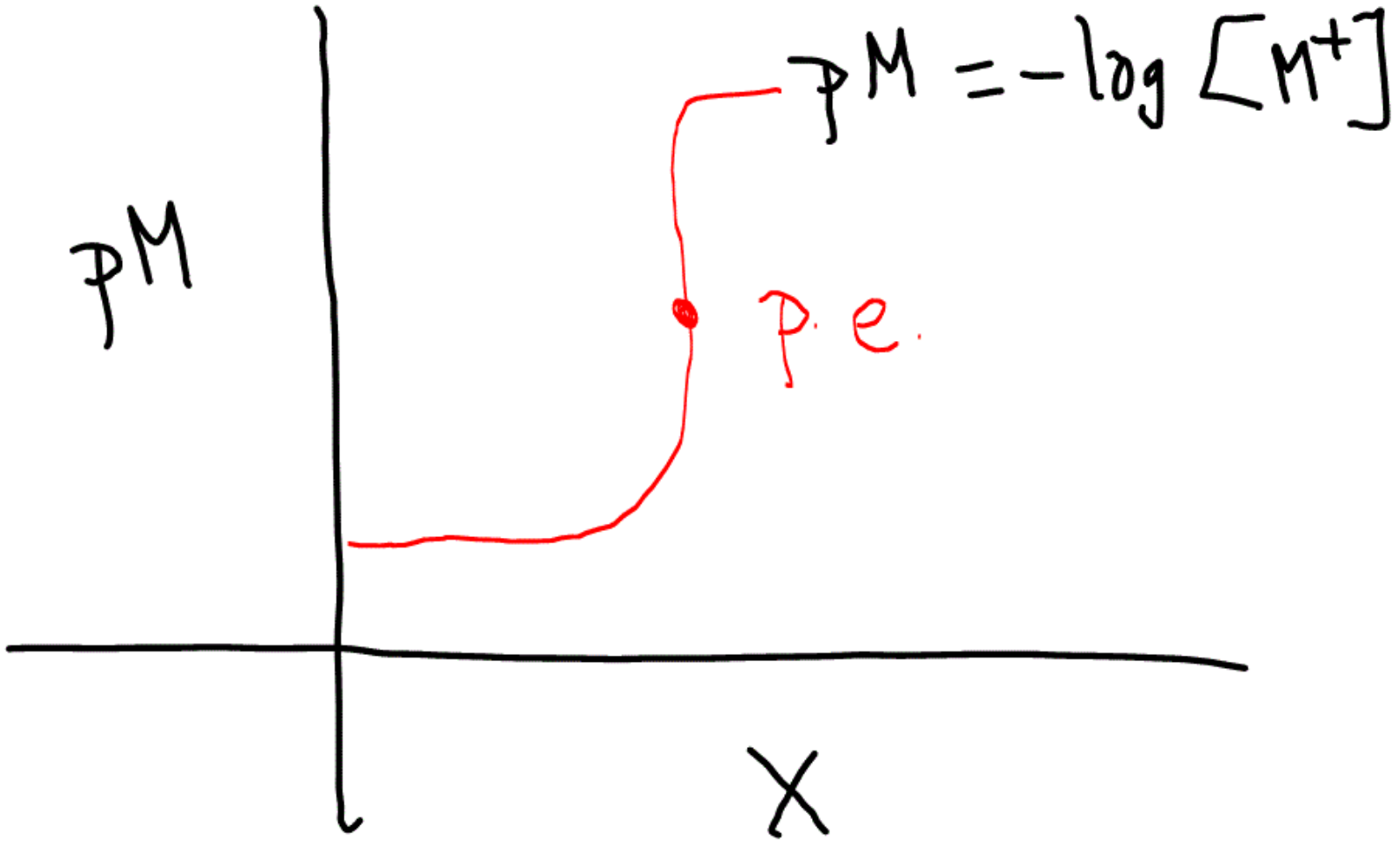
$$= \sqrt{\frac{1}{10^{8.61}}} = 10^{-8.61/2}$$

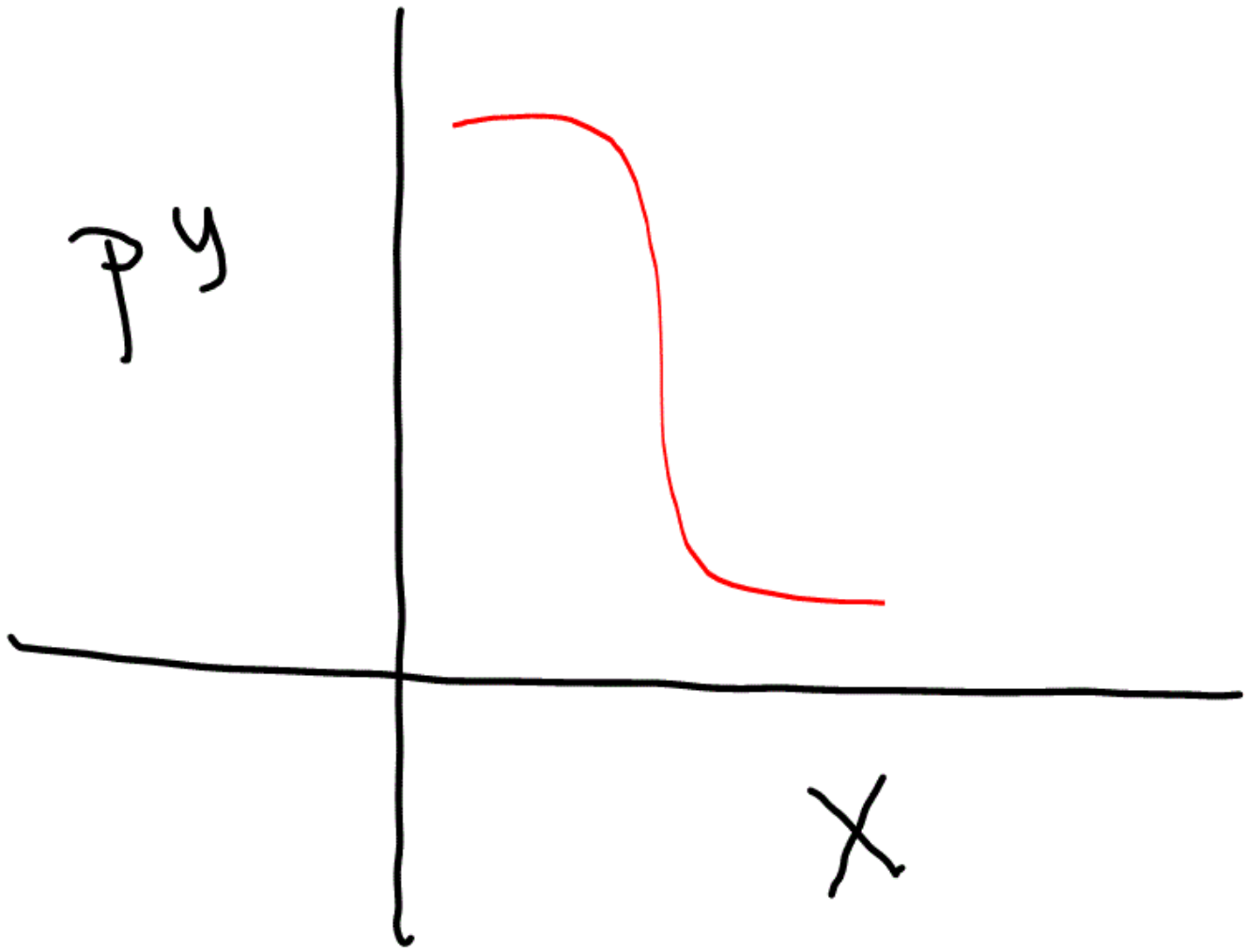
$$\varepsilon = 10^{-4.305}$$

$$\%\ Q \approx (1-\varepsilon)\,100$$

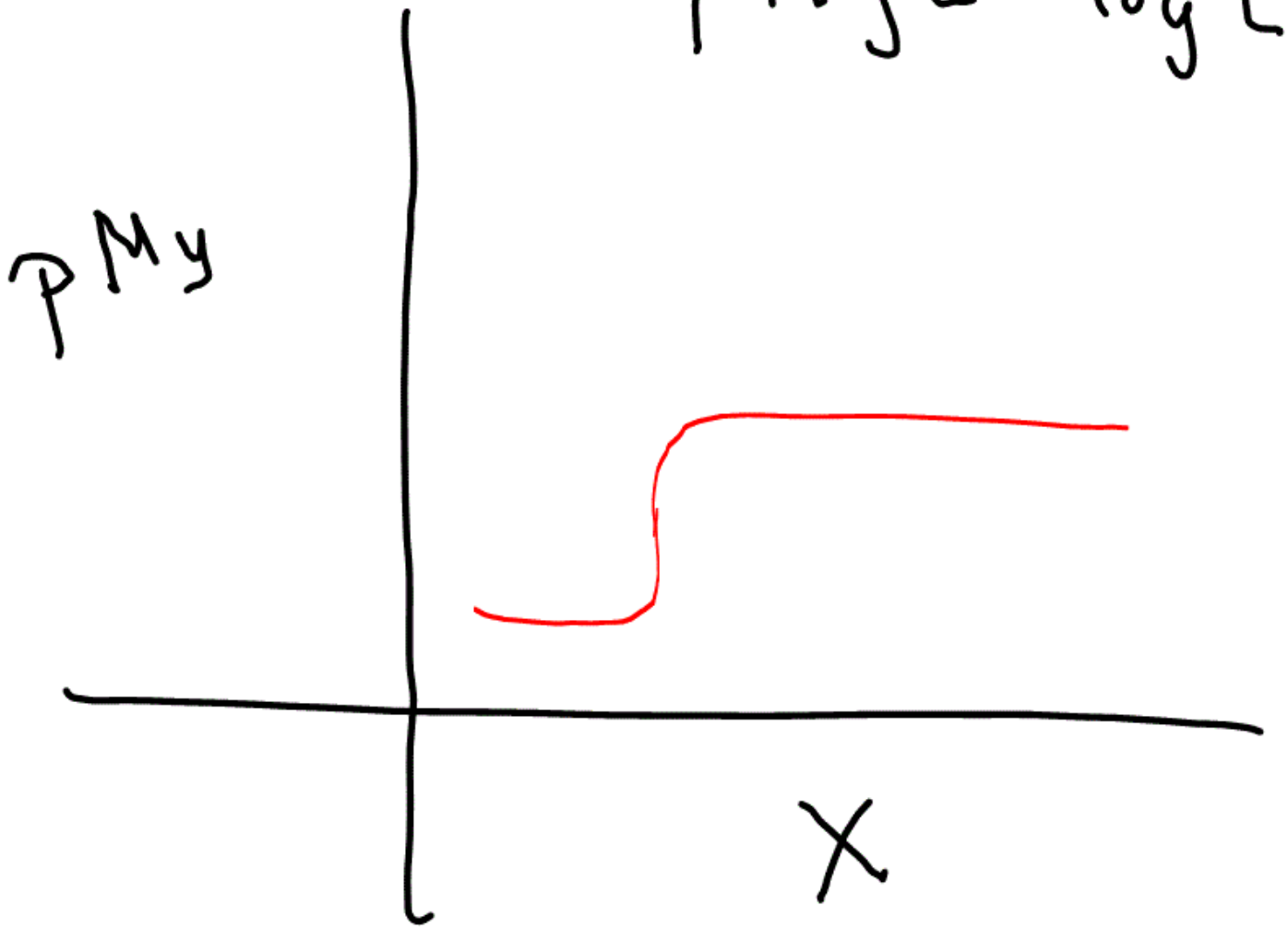
$$= (1 - 10^{-4.305})\,100$$

$$= 99.995\ \%$$


pM = −log [M+]
pM
p.e.
X


Py
X

$$pM_y = -\log [M_y]$$



$$Ca^{+2} + y^{-4} \rightleftharpoons [(Cay)^{-2}]$$

Inicio	C_o		
Ag		xC_o	
APE	$C_o(1-x)$	~ 0	xC_o
PE	εC_o	εC_o	C_o
DPE	~ 0	$C_o(x-1)$	C_o

$$\alpha_{Ca(OH^-)} = \frac{[Ca_T]}{[Ca_L]}$$

$$pCa_L = pM$$

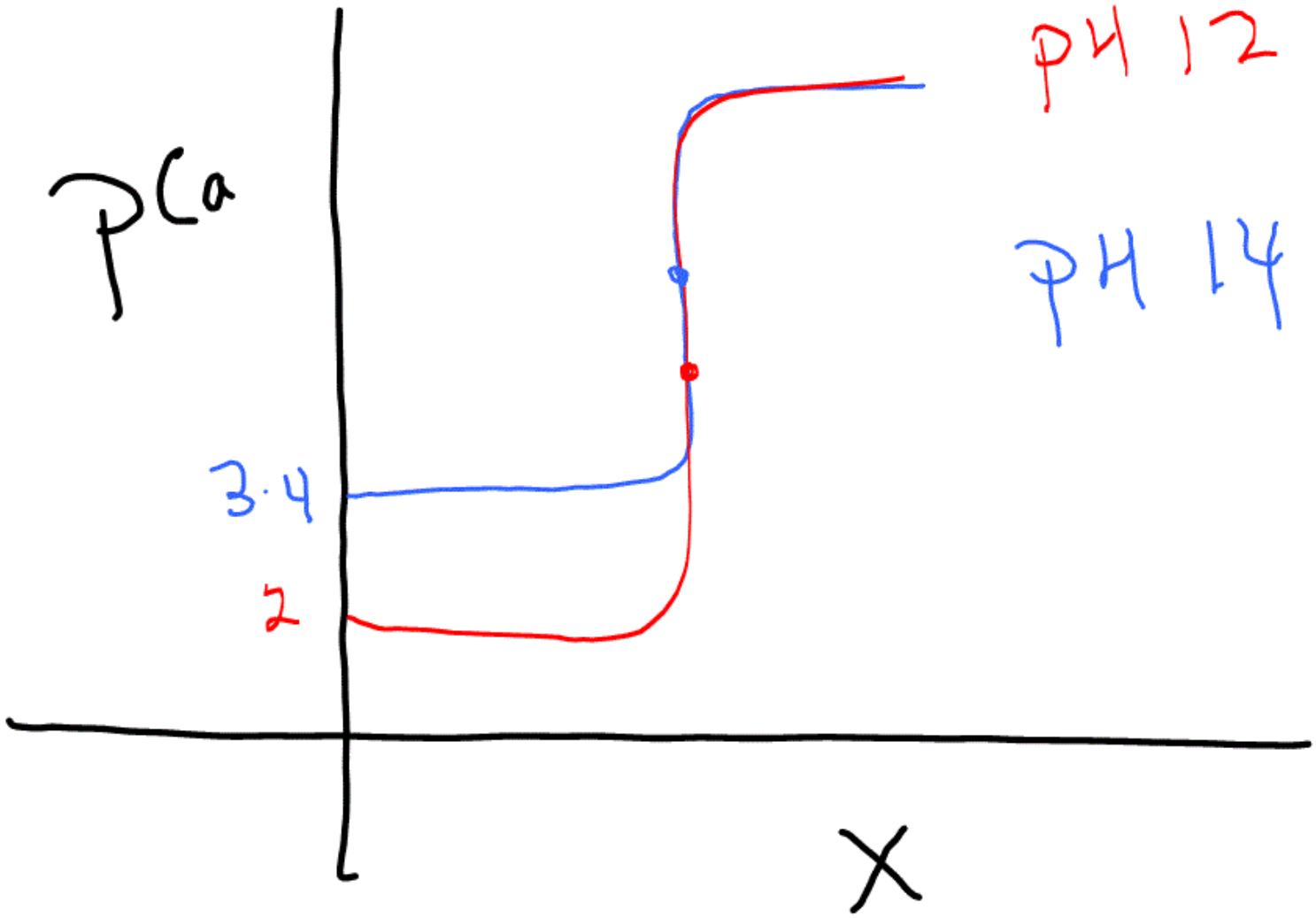
$$\left\{ [Ca_L] = \frac{[Ca_T]}{\alpha_{(CaOH^-)}} \right\} -\log$$

$$x = 0$$

$$pM = -\log [Ca_T] + \log \alpha_{(CaOH)}$$

$$= -\log 10^{-2} + \log 10^{0.08}$$

$$= 2 + 0.08 = 2.08$$


pH 12
pH 14
pCa
3.4
2
X

$$X = 0.5$$

$$pM = pCa = -\log\left[(a_T) + \log\alpha_{(a(OH))}\right.$$

$$= -\log\left[(C(1-x)\right] + \log 10^{0.08}$$

$$= -\log\left[10^{-2}(1-0.5)\right] + 0.08$$

$$= -\log\left[5 \times 10^{-3}\right] + 0.08$$

$$= 2.3 + 0.08 = 2.38$$

$X = 1$ p.e.

$([Ca^{+2}] = [y^{-4}])$ ✓

$[M^{+n}] = [y^{-4}]$

$$K_F' = \frac{C_0}{[C_{aT}]^2}$$

$$(C_{aT})^2 = \frac{C_0}{K_F'}$$

$$(C_{aT})^2 = \frac{C_0}{K_F'}$$

$$\alpha_{(aOH)} = \frac{[C_{aT}]}{[C_L]}$$

$$[C_{aT}] = \sqrt{\frac{C_0}{K_F'}}$$

$$[C_L] = \frac{[C_{aT}]}{\alpha_{(aOH}}$$

$$[Ca_L] = \frac{[C_{aT}]}{\alpha_{Ca(OH)}}$$

$$\left\{ [Ca_L] = \frac{\sqrt{\frac{C_0}{K_f'}}}{\alpha_{Ca(OH)}} \right\} - \log$$

$$pM = -\frac{1}{2}\log C_0 + \frac{1}{2}\log K_f' + \log \alpha_{Ca(OH)}$$

$$pM = -\frac{1}{2}\log C_0 + \frac{1}{2}\log K_f' + \log \alpha_{r(OH)}$$

$$= -\frac{1}{2}\log 10^{-2} + \frac{1}{2}\log 10^{10.61} + \log 10^{0.08}$$

$$= 1 + \frac{10.61}{2} + 0.08$$

$$= 1 + 5.305 + 0.08$$

$$pCa = 6.385$$

$$x = 1.5$$

$$K_F' = \frac{[(Ca\,y)^{-2}]}{[Ca_T]\,[y_T]}$$

$$= \frac{C_0}{[Ca_T]\,[C_0(x-1)]}$$

$$[Ca_T] = \frac{C_0}{C_0\,(x-1)\,K_F'}$$

$$[Ca_T] \simeq \frac{C_0}{C_0 (x-1) K_F'}$$

$$[Ca_L] \simeq \frac{[Ca_T]}{\alpha_{Ca(OH)}}$$

$$\left\{[Ca_L] = \frac{\frac{1}{(x-1) K_F'}}{\alpha_{Ca(OH)}}\right\} - \log$$

$$\left\{[Ca^{2+}] = \frac{\frac{1}{(x-1)\,K_F'}}{\alpha_{Ca(OH)}}\right\} - \log$$

$$pCa = pM = \log(x-1) + \log K_F' + \log \alpha_{Ca(OH)}$$

$$= \log(1.5-1) + \log 10^{10.61} + \log 10^{0.08}$$

$$= 10.61 + 0.08 - 0.3 = 10.388$$

$$X = 2$$

$$pCa = pM = \log(X-1) + \log K_f' + \log \alpha_{(OH)}$$

$$= \log(2-1) + \log 10^{10.61} + \log 10^{0.08}$$

$$= \log 1 + 10.61 + 0.08$$

$$= 10.69$$

	Catión	[ ] (mol/L)	
pH= 12.00	Ca+2	0.010000	CUANTITATIVO

Color del indicador por efecto del pH				
rojo	8.1	azul	12.4	naranja

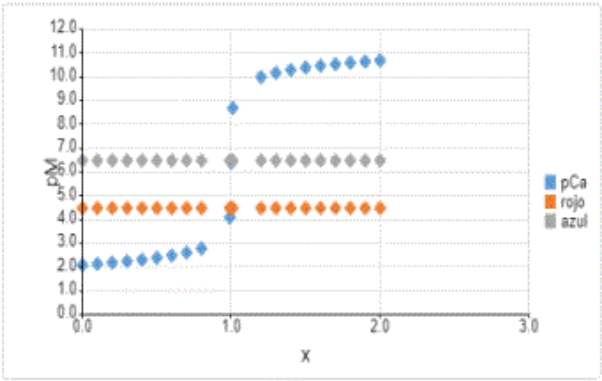
INDICADOR	1	% ERROR
APE	DPE	
4.08	8.69	→ 6.38
		PE

K´MInd=	1.2589e+6 / 4.2130e+0	=	2.99e+5	Calmagita
			LOG = 5.48	

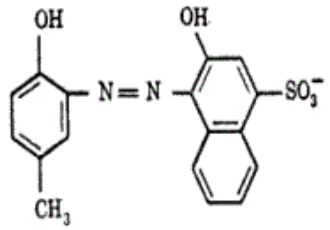
$\alpha L_{(H3O+)}$	1.0224e+0
αCa(OH-)	1.1996e+0

				rojo	azul
pM Trans	5.48	±	1 =	4.48	6.48

x	pCa
0.00	2.08
0.10	2.12
0.20	2.18
0.30	2.23
0.40	2.30
0.50	2.38
0.60	2.48
0.70	2.60
0.80	2.78
0.99	4.08
1.00	6.38
1.01	8.69
1.20	9.99
1.30	10.17
1.40	10.29
1.50	10.39
1.60	10.47
1.70	10.54
1.80	10.59
1.90	10.64
2.00	10.69



Calmagita



pH_{trans}	Rojo	8,1	Azul			12,4	Naranja
pH	7,0	8,0	9,0	10,0	11,0	12,0	13,0
$\log \alpha_{I(H)}$	6.5	4,7	3,4	2,4	1,4	0,5	0,1
pCa_{trans} a rojo		1,4	2,7	3,7	4,7	5,6	6,0
pMg_{trans} a rojo	1,6	3,4	4,7	5,7	6,7	7,7	8,0

Constantes logarítmicas: K^{H}_{HI} 12,4; $K^{H}_{H_2I}$ 8,1. K_{CaI} 6,1. K_{MgI} 8,1 (4).

Instrucción: llene los valores en las celdas de color amarillo

En las celdas de color verde aparecen los resultados

Complejo	LOG K_{ML}
Ca-AEDTA	10.70
	K_{ML}
	5.0119e+10

Indicador	LOG K_{ML}
Calmagita	6.10
	K_F
	1.2589e+6

Indicador	pKa_1	pKa_2	pKa_3	pKa_4	pKa_5
Calmagita	8.10	12.40	-34.00	-30.00	-20.00

$$pH = 12$$

$$pM_{trans} =$$

$$K'_{f\,Ca\,Ind} = \frac{K_{f\,Ca\,Ind}}{\alpha_{Ca(OH)}\,\alpha_{Ind(H_3O^+)}}$$

$$K'_{f\,Ca\,Ind} = \frac{10^{6.1}}{100.08\;\;10^{0.5433}}$$

$$\alpha_{Cd(Ind)} = 1 + \beta_{p1}[H_3O^+] + \beta_{p2}[H_3O^+]^2$$

$$\beta_{p1} = \frac{1}{K_{a2}} \qquad \beta_{p2} = \frac{1}{K_{a2}K_{a1}}$$

$$\beta_{p1} = \frac{1}{10^{-12.4}} = 10^{12.4}$$

$$\beta_{p2} = \frac{1}{10^{-12.4}\,10^{-8.1}} = 10^{20.5}$$

$$\alpha_{Cd(Ind)} = 1 + \beta_{p1}[H_3O^+] + \beta_{p2}[H_3O^+]^2$$

$$= 1 + 10^{12.4}[10^{-12}] + 10^{20.5}[10^{-12}]^2$$

$$= 1 + 10^{0.4} + 10^{-3.5}$$

$$= 1 + 2.51 + 3.16 \times 10^{-4}$$

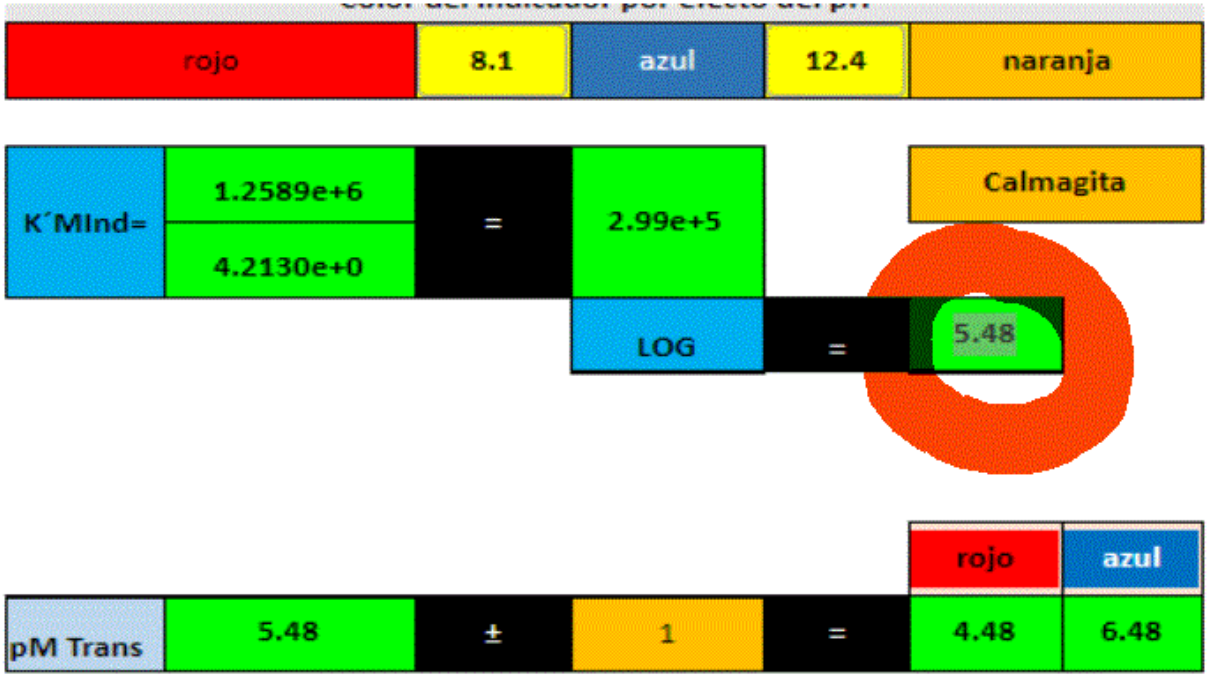
$$= 3.51 = 10^{0.5453}$$

$$pM_{trans} =$$

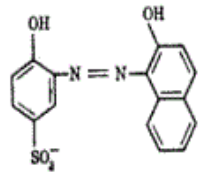
$$KF'_{calnd} = \frac{KF_{calnd}}{\alpha_{Ca(OH)} \alpha_{Ind(H_3O^+)}}$$

$$KF'_{calnd} = \frac{10^{6.1}}{100.08 \; 10^{0.5433}}$$

$$= 10^{5.47} = \log 10^{5.47} = 5.48$$


rojo
8.1
azul
12.4
naranja
K´MInd=
1.2589e+6
4.2130e+0
=
2.99e+5
Calmagita
LOG
=
5.48
rojo
azul
pM Trans
5.48
±
1
=
4.48
6.48

Violeta de solocromo R



pH_{trans}			Rojo		7,0		Azul			
pH	3,0	4,0	5,0	6,0	7,0	8,0	9,0	10,0	11,0	12,0
$\log \alpha_{I(H)}$	14,0	12,0	10,0	8,0	6,3	5,0	4,0	3,0	2,0	1,0
pCa_{trans} a rojo						0,6	1,6	2,6	3,6	4,6
pCu_{trans} a rojo	6,8	8,8	10,8	12,8	14,5	15,8	16,8	17,8		
pMg_{trans} a rojo					1,3	2,6	3,6	4,6	5,6	6,6
pNi_{trans} a rojo	0,9	2,9	4,9	6,9	8,7	10,6	12,5	14,5		
pZn_{trans} a rojo		0,5	2,5	4,5	6,2	7,5	8,5	9,5	11,1	

Constantes logaritmicas (corregidas aproximadamente a $\mu=0,1$): K_{HI} 13,0; $K^{H}_{H_2I}$ 7,0 (5). K_{CaI} 5,6; $K^{2I}_{CaI_2}$ 8,7. K_{CuI} 20,8. K_{MgI} 7,6; $K^{2I}_{MgI_2}$ 12,7. K_{NiI} 14,9; $K^{2I}_{NiI_2}$ 25,5. K_{ZnI} 12,5; $K^{2I}_{ZnI_2}$ 20,0 (6); $C_I=10^{-5}\,M$

Complejo	LOG K_{ML}
Ca-AEDTA	10.70
	K_{ML}
	5.0119e+10

Indicador	LOG K_{ML}
Violeta Sol	5.60
	K_F
	3.9811e+5

Indicador	pKa_1	pKa_2	pKa_3	pKa_4	pKa_5
Violeta solocr	7.00	13.00	-34.00	-30.00	-20.00

Color del indicador por efecto del pH				
rojo	7	azul	13	naranja

K´MInd=	3.9811e+5 / 1.3196e+1	=	3.02e+4	Violeta Sol
		LOG	=	4.48

				rojo	azul
pM Trans	4.48	±	1	=	3.48	5.48

x	pCa
0.00	2.08
0.10	2.12
0.20	2.18
0.30	2.23
0.40	2.30
0.50	2.38
0.60	2.48
0.70	2.60
0.80	2.78
0.99	4.08
1.00	6.38
1.01	8.69
1.20	9.99
1.30	10.17
1.40	10.29
1.50	10.39
1.60	10.47
1.70	10.54
1.80	10.59
1.90	10.64
2.00	10.69

no es un buen indicador

Complejos solubles

Instrucción: llene los valores en las celdas de color amarillo

En las celdas de color verde aparecen los resultados

Catión	[] (mol/L)	pH=	2.00
Bi+3	0.010000		

Complejo	LOG K_{ML}
Bi-AEDTA	22.80
K_{ML}	
6.3096e+22	

Indicador	LOG K_{ML}
Naranja Xilen(	31.20
K_F	
1.5849e+31	

Ligante	pk_1	pka_2	pka_3	pka_4	pka_5	pka_6
AEDTA	0.00	1.50	2.00	2.65	6.25	10.35
	β1	β2	β3	β4	β5	β6
AEDTA	2.2387e+10	3.9811e+16	1.7783e+19	1.7783e+21	5.6234e+22	5.6234e+22
Bi(OH)	2.5119e+12	1.0000e+0	1.0000e+0	1.0000e+0	1.0000e+0	1.0000e+0
LOG	12.40	0.00	0.00	0.00	0.00	0.00

Indicador	pKa_1	pKa_2	pKa_3	pKa_4	pKa_5
Naranja Xilen	2.60	3.20	6.40	10.50	12.30

Nota: Si el indicador es un diácido llenar las celdas con el valor de pka1 y pka2 respectivamente, en las demás celdas introducir valores negativos

pH de inicio de precipitación

	pKs
Bi(OH)3	30.36

Bi(OH)3	↔	Bi+3	3OH-

pH	4.56

K'_{ML}=	6.3096e+22 / 1.5883e+14	=	3.9725e+8
		LOG	= 8.60

Ks=	[Bi+3]	[OH]3	=	4.3652e-31		
[OH-]3	=	Ks / [Bi+3]	=	4.3652e-31 / 0.01	=	4.3652e-29

[OH]	=	3.5985e-10

ε=	5.0173e-4	
%Q=	99.9498	CUANTITATIVO

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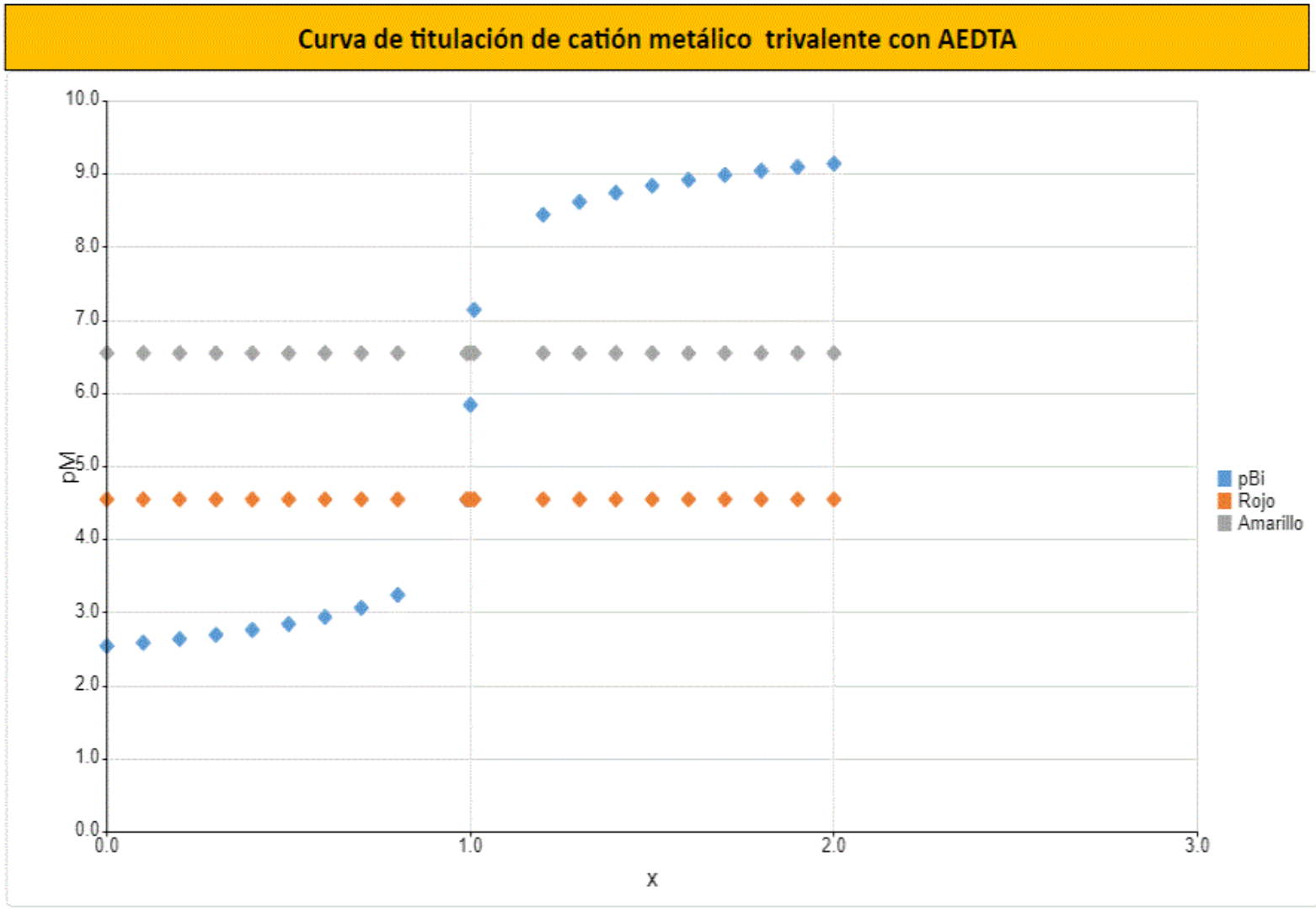
Curva de titulación de catión metálico trivalente con AEDTA
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
pM
0.0
1.0
2.0
3.0
x
pBi
Rojo
Amarillo

Complejos solubles

Instrucción: llene los valores en las celdas de color amarillo

En las celdas de color verde aparecen los resultados

Catión	[] (mol/L)	pH=	12.00
Bi+3	0.010000		

Complejo	LOG K_{ML}
Bi-AEDTA	22.80
K_{ML}	
6.3096e+22	

Indicador	LOG K_{ML}
Naranja Xilen	31.20
K_f	
1.5849e+31	

Ligante	pk_1	pka_2	pka_3	pka_4	pka_5	pka_6
AEDTA	0.00	1.50	2.00	2.65	6.25	10.35
	β1	β2	β3	β4	β5	β6
AEDTA	2.2387e+10	3.9811e+16	1.7783e+19	1.7783e+21	5.6234e+22	5.6234e+22
Bi(OH)	2.5119e+12	1.0000e+0	1.0000e+0	1.0000e+0	1.0000e+0	1.0000e+0
LOG	12.40	0.00	0.00	0.00	0.00	0.00

Indicador	pKa_1	pKa_2	pKa_3	pKa_4	pKa_5
Naranja Xilen	2.60	3.20	6.40	10.50	12.30

Nota: Si el indicador es un diácido llenar las celdas con el valor de pka1 y pka2 respectivamente, en las demás celdas introducir valores negativos

pH de inicio de precipitación

	pKs
Bi(OH)3	30.36

Bii(OH)3	↔	Bi+3	3OH-

pH	4.56

K'_{ML}=	6.3096e+22	=	2.4569e+12
	2.5681e+10		
		LOG	= 12.39

Ks=	[Bi+3]	[OH]3	=	4.3652e-31		
[OH-]3	=	Ks	=	4.3652e-31	=	4.3652e-29
		[Bi+3]		0.01		

[OH]	=	3.5985e-10

Ɛ=	6.3798e-6	
%Q=	99.9994	CUANTITATIVO

FES ZARAGOZA

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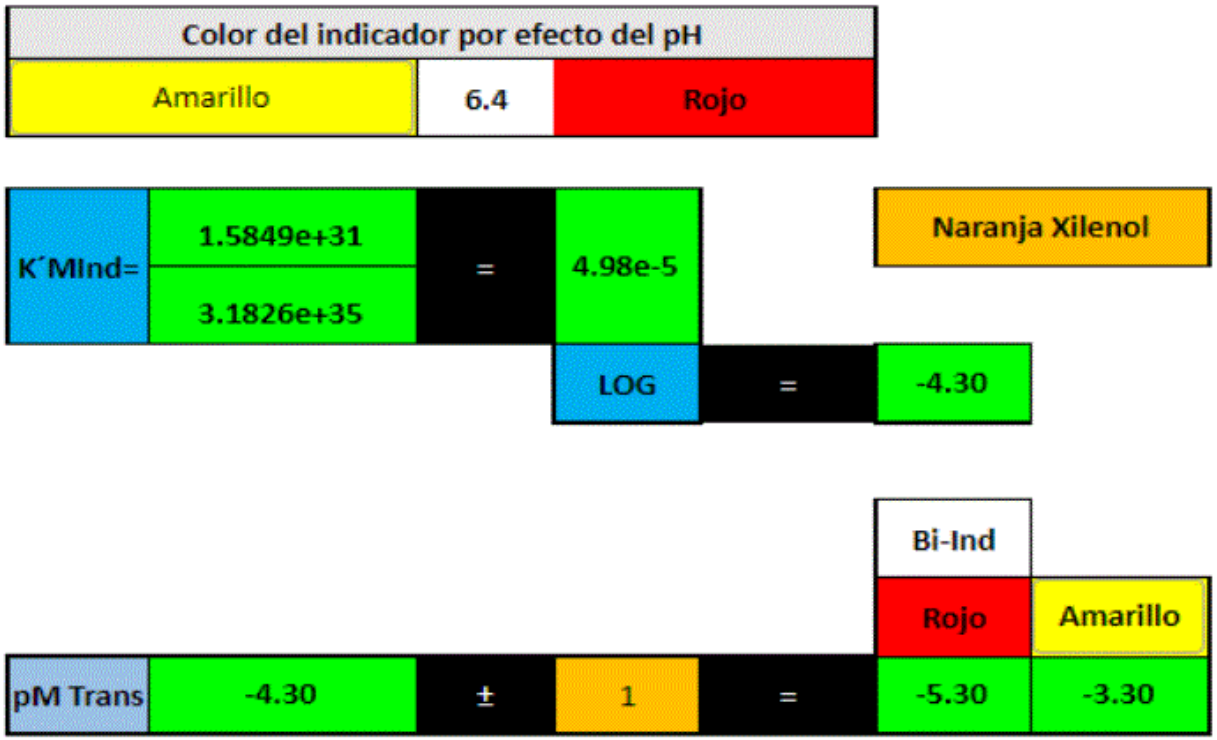
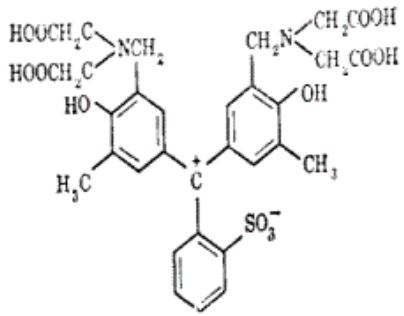

Color del indicador por efecto del pH
Amarillo
6.4
Rojo
K´MInd=
1.5849e+31
3.1826e+35
=
4.98e-5
Naranja Xilenol
LOG
=
-4.30
Bi-Ind
Rojo
Amarillo
pM Trans
-4.30
±
1
=
-5.30
-3.30

Naranja de xilenol (18)



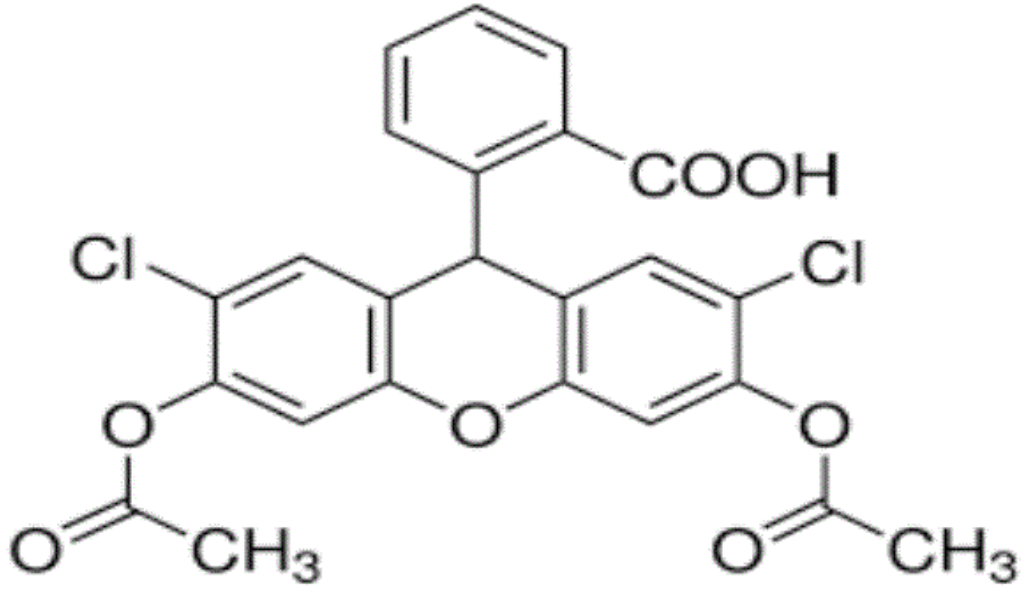
pH_{trans}					Amarillo					6,4	Rojo
pH	0	1,0	2,0	3,0	4,0	4,5	5,0	5,5	6,0	6,5	7,0
log $\alpha_{I(H)}$	35,0	30,0	25,1	20,7	17,3	15,7	14,2	12,8	11,3	10,0	8,9
log $\alpha_{HI(H)}$	22,7	18,7	14,8	11,4	9,0	7,9	6,9	6,0	5,0	4,3	3,6
log $\alpha_{H_2I(H)}$	12,2	9,2	6,3	3,9	2,5	1,9	1,4	1,0	0,5	0,2	
pBi_{trans} a rojo		4	5,4	6,8							
pCd_{trans} a rojo						4	4,5	5,0	5,5	6,3	6,8
pHg_{trans} a rojo							7,4	8,2	9,0		
pLa_{trans} a rojo						4,0	4,5	5,0	5,6	6,7	
pPb_{trans} a rojo				4,2	4,8	6,2	7,0	7,6	8,2		
pTh_{trans} a rojo		3,6	4,9	6,3							
pZn_{trans} a rojo						4,1	4,8	5,7	6,5	7,3	8,0
pZr_{trans} a rojo	7,5										

Constantes logaritmicas: K_{HI} 12,3; $K^{H}_{H_2I}$ 10,5; $K^{H}_{H_3I}$ 6,4; $K^{H}_{H_4I}$ 3,2; $K^{H}_{H_5I}$ 2,6 (19). (Los valores que se dan de pM_{trans} son experimentales: Bi, Cd, Hg, La, Pb, Th, Zn (17); Zn (20))

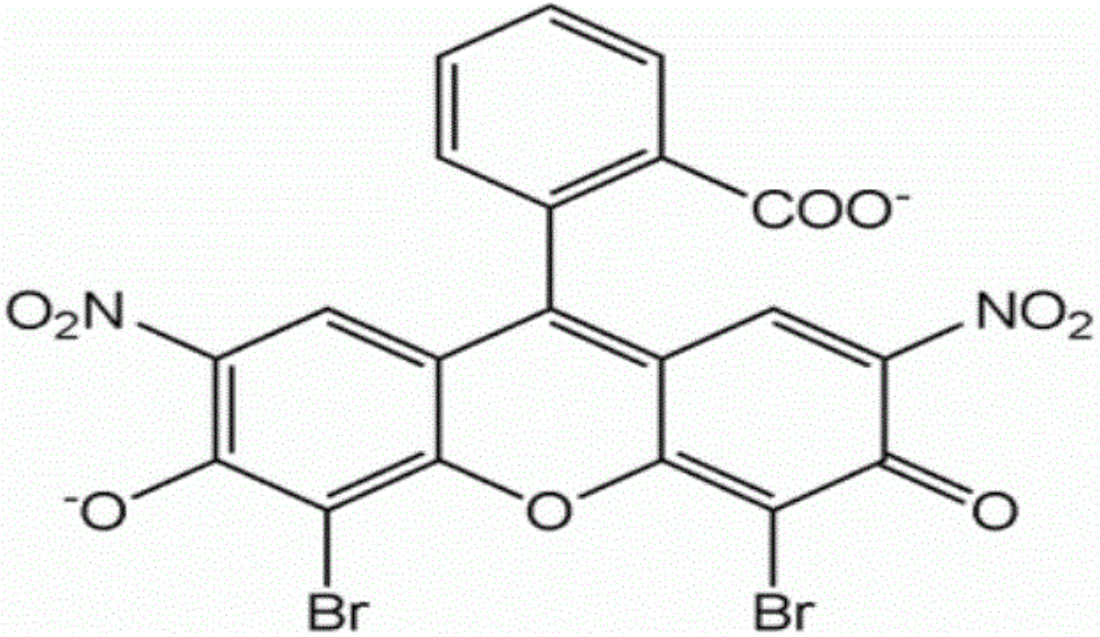
Metodos PP

- Mohr
- Fajans
- Volhard T
- potenciométrico

Indicador de Adsorción



Diclorofluresceína



Eosina