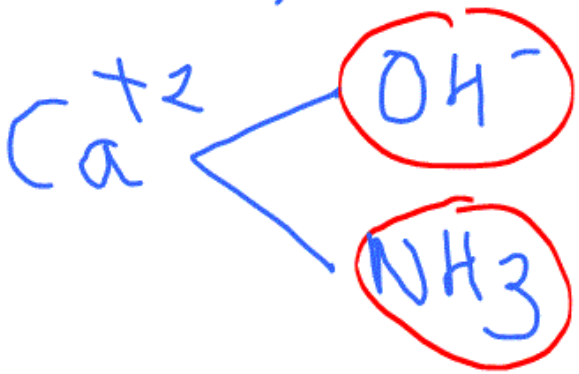
Clase 11 12 noviembre 2021

Título de la nota 12/11/2021

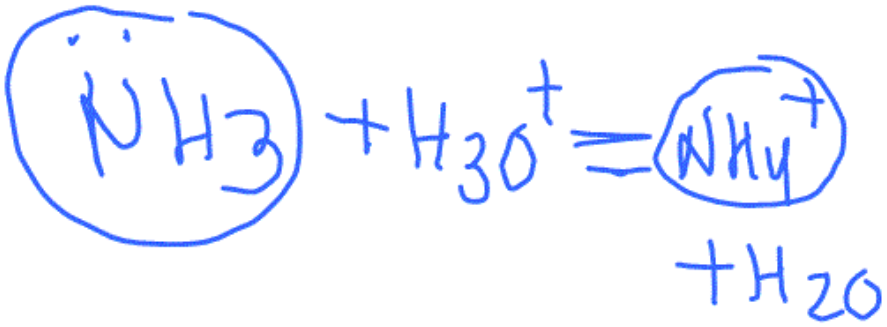
$$Ca^{+2} + y^{-4} \rightleftharpoons CaY^{-2} = K_F'$$

Inicio	C_0		
Ag		XC_0	
APE	$C_0(1-x)$	~ 0	XC_0
PE	εC_0	εC_0	C_0
DPE	~ 0	$C_0(x-1)$	C_0

Inicio $x = 0$ $pH = 12$



x



$$\alpha_{Ca(OH)_1(NH_3)} = \alpha_{Ca(OH)} + \alpha_{Ca(NH_3)} + (n-1)$$

$n = 2$

$$= \alpha_{Ca(OH)} + \alpha_{Ca(NH_3)} + 1$$

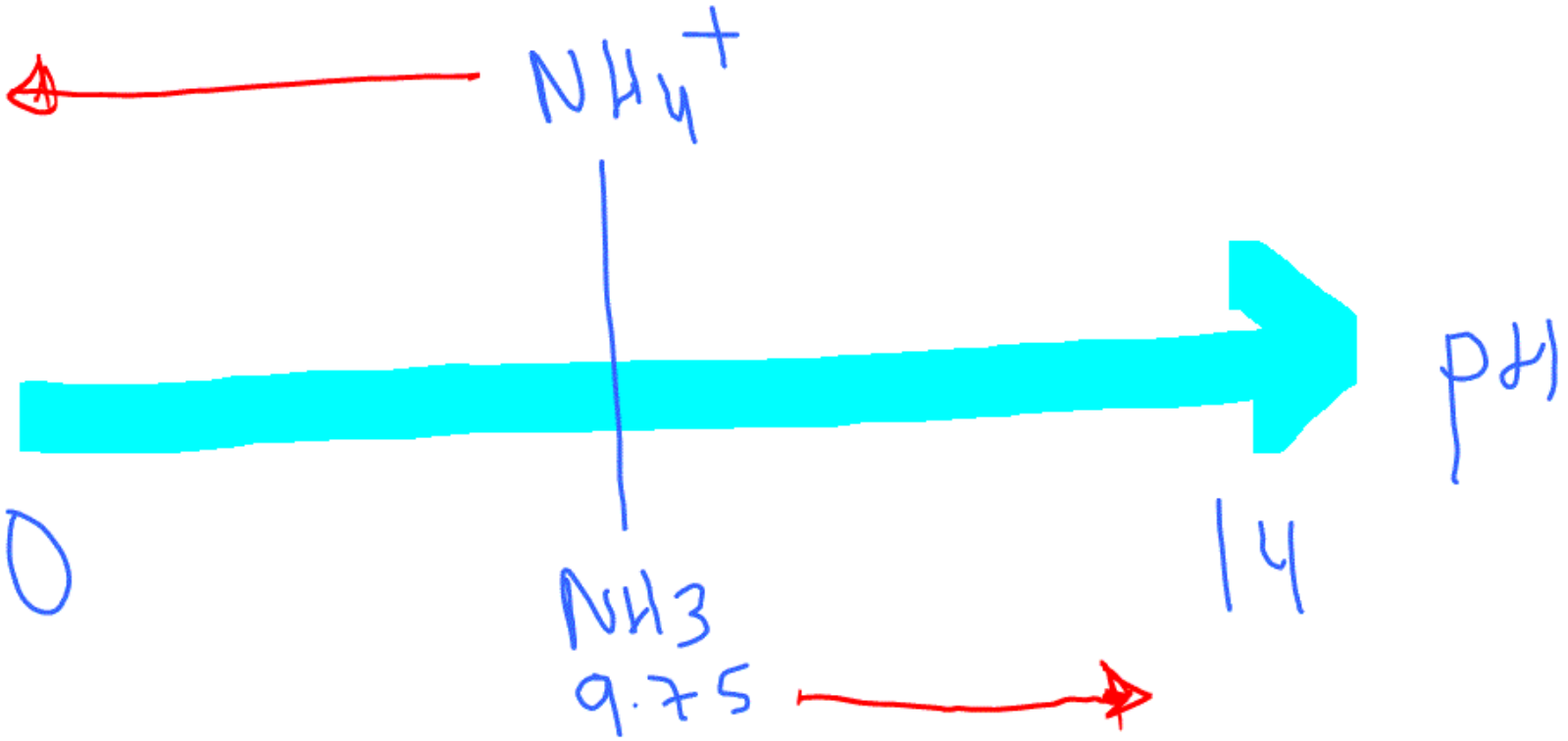
$$\alpha_{Ca(NH_3)} = 1 + 10^{-0.2}[NH_3] + 10^{-0.8}[NH_3]^2 + 10^{-1.6}[NH_3]^3 + 10^{-2.7}[NH_3]^4$$

$$[NH_3]_L = 0.01$$

$$= 1 + 10^{-0.2}[10^{-2}] + 10^{-0.8}[10^{-2}]^2 + 10^{-1.6}[10^{-2}]^3 + 10^{-2.7}[10^{-2}]^4$$

$$\alpha_{Ca(NH_3)} = 1 + 10^{-2.2} + 10^{-4.8} + 10^{-7.6} + 10^{-10.7}$$

$$= 1.000631$$



$$\alpha_{NH_3(H_3O^+)} = 1 + \beta_p [H_3O^+]$$

$$= 1 + 10^{9.75} [H_3O^+]$$

$$= 1 + 10^{9.75} [10^{-11.75}]$$

$$= 1 + 10^{-2}$$

$$= 1 + 0.01 = 1.01$$

$$\alpha_{NH_3(H_3O^+)} = \frac{[NH_3]_T}{[NH_3]_L}$$

$$[NH_3]_L = \frac{[NH_3]_T}{\alpha_{NH_3(H_3O^+)}}$$

$$= \frac{\boxed{0.01}}{1.01} = \boxed{0.0099}$$

$$X = 0$$

$$\alpha_{Ca(OH)} = \frac{[Ca^{+2}]_+}{[Ca^{+2}]_L}$$

$$\alpha_{Ca(OH)} = \frac{[Ca^{+2}]}{[Ca^{+2}]}$$

$$pH = 12$$

$$= 1.199$$

$$X = 0$$

$$\alpha_{Ca(OH)} = \frac{[Ca^{+2}]'}{[Ca^{+2}]}$$

$$[Ca^{+2}] = \frac{[Ca^{+2}]'}{\alpha_{Ca(OH)}}$$

$$-\log$$

$$pCa^{+2} = -\log C_0 + \log \alpha_{Ca(OH)}$$

$$X = 0 \qquad \alpha_{Ca(OH)} = 1.199$$

$$= 10^{0.078}$$

$$pM = -\log C_0 + \log \alpha_{M(OH)}$$

$$= -\log 10^{-2} + \log 10^{0.078}$$

$$= 2 + 0.078$$

$$= 2.078 \simeq 2.8$$

$$X = 0.5$$

$$pCa = -\log C_0(1-x) + \log \alpha C_a(OH)$$

$$= -\log 10^{-2}(1-0.5) + \log 10^{0.078}$$

$$= -\log 10^{-2}(0.5) + \log 10^{0.078}$$

$$= -\log 5 \times 10^{-3} + 0.078$$

$$= 2.378$$

$$X = 1$$

$$[Ca^{+2}]' = [y^{-4}]'$$

$$K_F' = \frac{[Ca\,y^{-2}]}{[Ca^{+2}]\,[y^{-4}]}$$

$$K_F' = \frac{[Ca\,y^{-2}]}{[Ca^{+2}]^2} = \frac{Co}{[Ca^{+2}]^2}$$

$$K_f = 10^{10.61}$$

$$10^{10.61} = \frac{C_0}{[Ca^{+2}]^2}$$

$$[Ca^{+2}]^2 = \frac{C_0}{10^{10.61}}$$

$$[Ca^{+2}] = \sqrt{\frac{C_0}{10^{10.61}}}$$

$$[Ca^{+2}] = \frac{[Ca^{+2}]}{\alpha_{Ca(OH)}}$$

$$[Ca^{+2}] = \left[\frac{\sqrt{Co/10^{10.61}}}{10^{0.078}}\right] - \log$$

$$pCa = -\frac{1}{2}\log Co + \frac{1}{2}\log 10^{10.61} + \log 10^{0.078}$$

$$pCa = -\frac{1}{2}\log C_o + \frac{1}{2}\log 10^{10.61} + \log 10^{0.078}$$

$$= -\frac{1}{2}\log 10^{-2} + \frac{1}{2}(10.61) + 0.078$$

$$= 1 + 0.078 + 5.305$$

$$= 6.383$$

$$X = 1$$

$$pM = -\frac{1}{2}\log C_o + \frac{1}{2}\log K'_F + \log \alpha_M$$

$$X = 1.5$$

$$K_f' = \frac{[Ca^{+2}]}{[Ca^{+2}][y^{-4}]}$$

$$[Ca^{+2}] = \frac{C_0}{K_f' C_0 (x-1)}$$

$$[Ca^{+2}] = \frac{1}{K_f' (x-1)}$$

$$[Ca^{+2'}] = \frac{1}{K_F' (x-1)}$$

$$\alpha_{Ca(OH)} = \frac{[Ca^{+2'}]}{[Ca^{+2}]}$$

$$[Ca^{+2}] = \frac{[Ca^{+2'}]}{\alpha_{Ca(OH)}}$$

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

$$pCa = \log K_F' + \log(X-1) + \log \alpha_{Ca(OH)_2}$$

$$= \log 10^{10.61} + \log(1.5-1) + \log 10^{0.078}$$

$$= 10.61 + 0.078 + \log 0.5$$

$$= 10.61 + 0.078 + \log 0.5$$

$$= 10.39$$

$$x = 1.5$$

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

$$X = 2$$

$$pCa = \log 10^{10.61} + \log(2-1) + \log 10^{0.078}$$

$$= 10.61 + 0.078 = 10.69$$

Datos | Curva de titulación | Curva 2

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

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

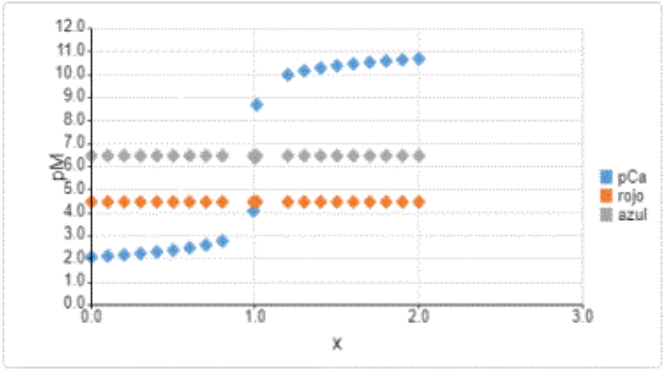
INDICADOR	1	% ERROR
APE	DPE	
4.08	8.69	→ 6.38
		PE

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

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

pM Trans	5.48	±	1	=	rojo 4.48	azul 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



Color $[Ca^{+2}\,Ind] =$ rojo

$$\alpha_{Ind(H_3O^+)} = 1 + \beta_1[H_3O^+] + \beta_2[H_3O^+]^2$$

$$= 1 + 10^{12.4}[H_3O^+] + 10^{20.5}[H_3O^+]^2$$

$$\beta_1 = \frac{1}{Ka_2} \qquad \beta_1 = \frac{1}{10^{-12.4}} = 10^{12.4}$$

$$\beta_2 = \frac{1}{Ka_2 Ka_1} = \frac{1}{10^{-12.4}\,10^{-8.1}} = 10^{20.5}$$

a pH = 12

$$= 1 + 10^{12.4}[H_3O^+] + 10^{20.5}[H_3O^+]^2$$

$$\alpha_{Ind(H_3O^+)} = 1 + 10^{12.4}[10^{-12}] + 10^{20.5}[10^{-12}]^2$$

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

$$= 3.5122 = 10^{0.5455}$$

$$\log \alpha_{Ind(H_3O^+)} = 0.5455$$

Calmagita								
				β_1	$[H_3O^+]$		β_2	$[H_3O^+]^2$
$\alpha Ind(H_3O^+)$	=	1	+	2.5119E+12	1E-12	+	3.1623E+20	1E-24
$\alpha Ind(H_3O^+)$	=	1	+	2.5118864		+	0.00031623	
$\alpha Ind(H_3O^+)$	=	3.5122E+00						
		LOG	=	0.5455796				

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

$$= \frac{10^{6.1}}{10^{0.078}\;10^{0.5455}}$$

$$= 10^{5.476} \simeq 10^{5.48}$$

$$pM_{transición} \pm 1 = \log K_f'(a_{ind}) \pm 1$$

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

$$= 5.48 \pm 1$$

$$pM = 4.48 - 6.48$$

Color	→	color
Rojo		azul

1.1. APE Co 1.1.

$$[Ca^{+2}] = (10^{-2})(10^{-2}) = 10^{-4}$$

$$[Ca^{+2}] = \frac{[Ca^{+2}]}{2\,Ca(OH)}$$

$$pCa = -\log C_o(10^{-2}) + \log 2\,Ca(OH)$$

$$= -\log 10^{-2}(10^{-2}) + \log 10^{0.078}$$

$$pCa = -\log 10^{-4} + \log 10^{0.078}$$

$$= 4 + 0.078 = 4.078 = 4.08$$

$$1.1 \cdot DPE$$

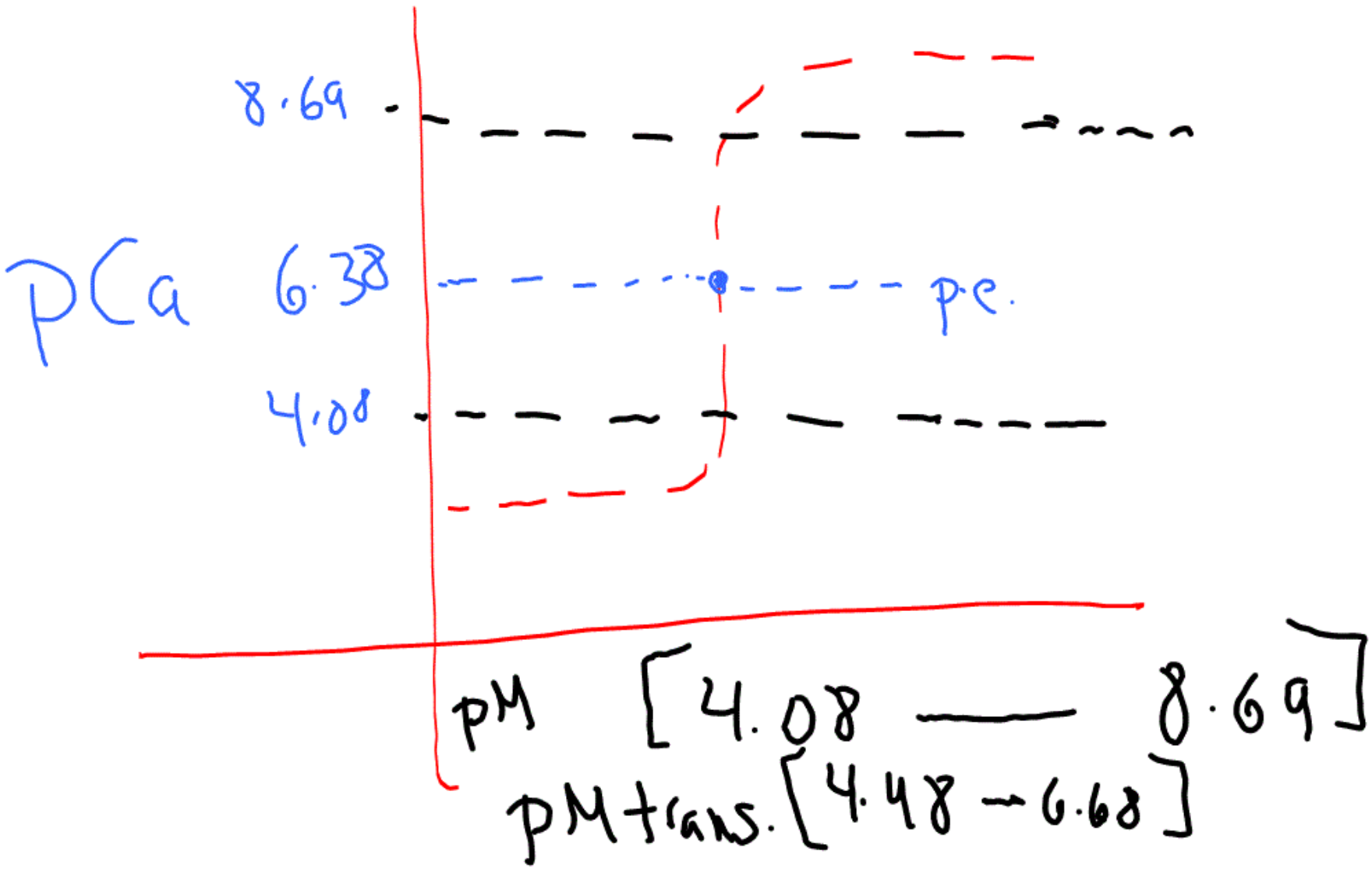
INDICADOR		1	% ERROR
APE	DPE		
4.08	8.69	→	6.38
			PE

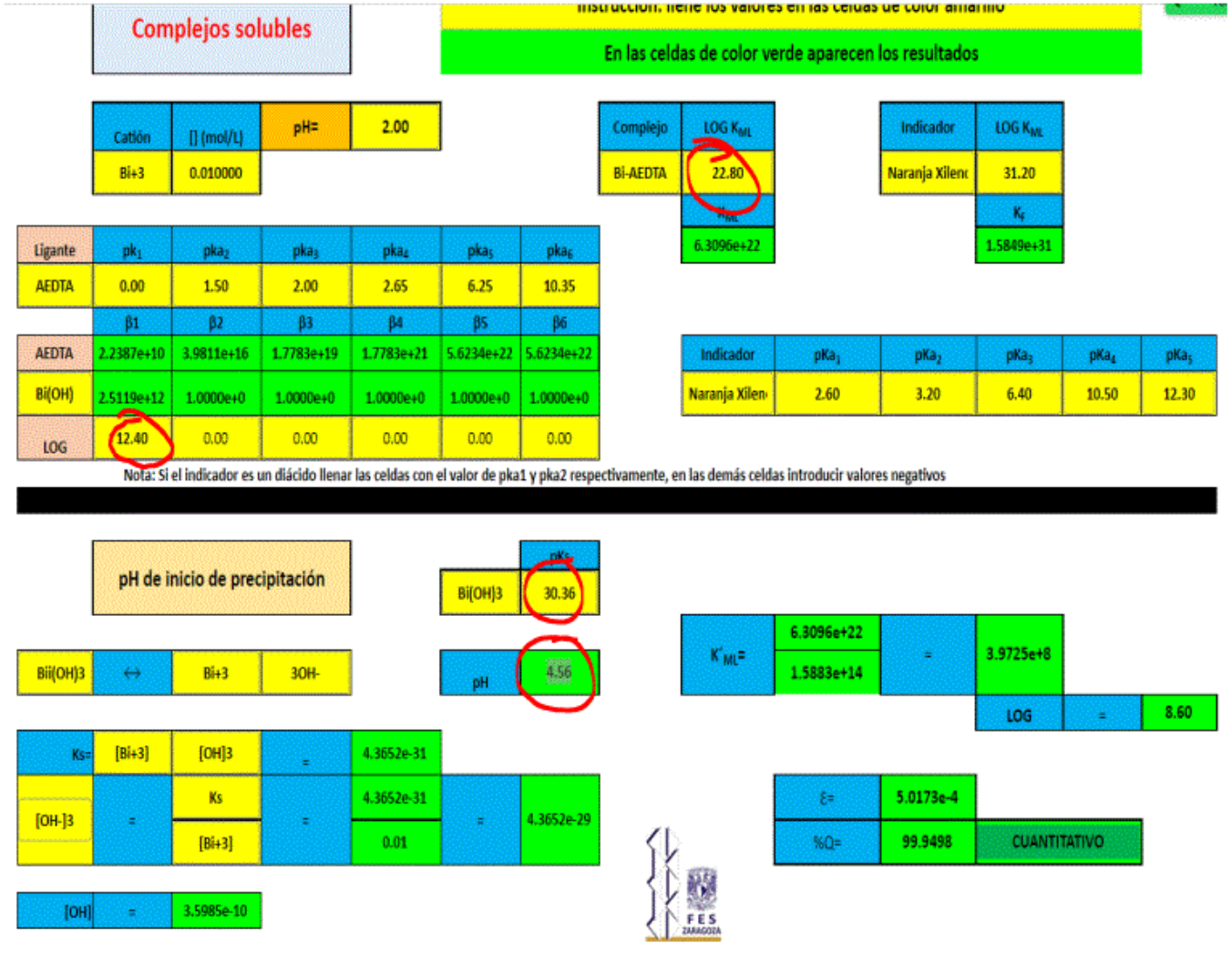
$$pCa\ p.e. = 6.38$$

$$6.38 - 4.08 = 2.3$$

$$1.1 \cdot DPE = 6.38 + 2.3$$

$$= 8.68$$


8.69
pCa
6.38
pe.
4.08
pM [4.08 —— 8.69]
pM trans. [4.48 – 6.68]


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 | pk1 | pka2 | pka3 | pka4 | pka5 | pka6
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 | pKa1 | pKa2 | pKa3 | pKa4 | pKa5
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 / 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
ε= | 5.0173e-4
%Q= | 99.9498 | CUANTITATIVO
[OH] | = | 3.5985e-10
FES ZARAGOZA
Dr Juan Carlos Vázquez Lira 2021
Con apoyo del programa UNAM-DGAPA-PAPIME PE-202021

$$[Bi^{+3}] = \frac{[Bi^{+3}]}{\alpha_{Bi(OH)}}$$

$$= \frac{10^{-2}}{10^{10}}$$

$$= 10^{-12}$$