Clase 11 4 diciembre 2020

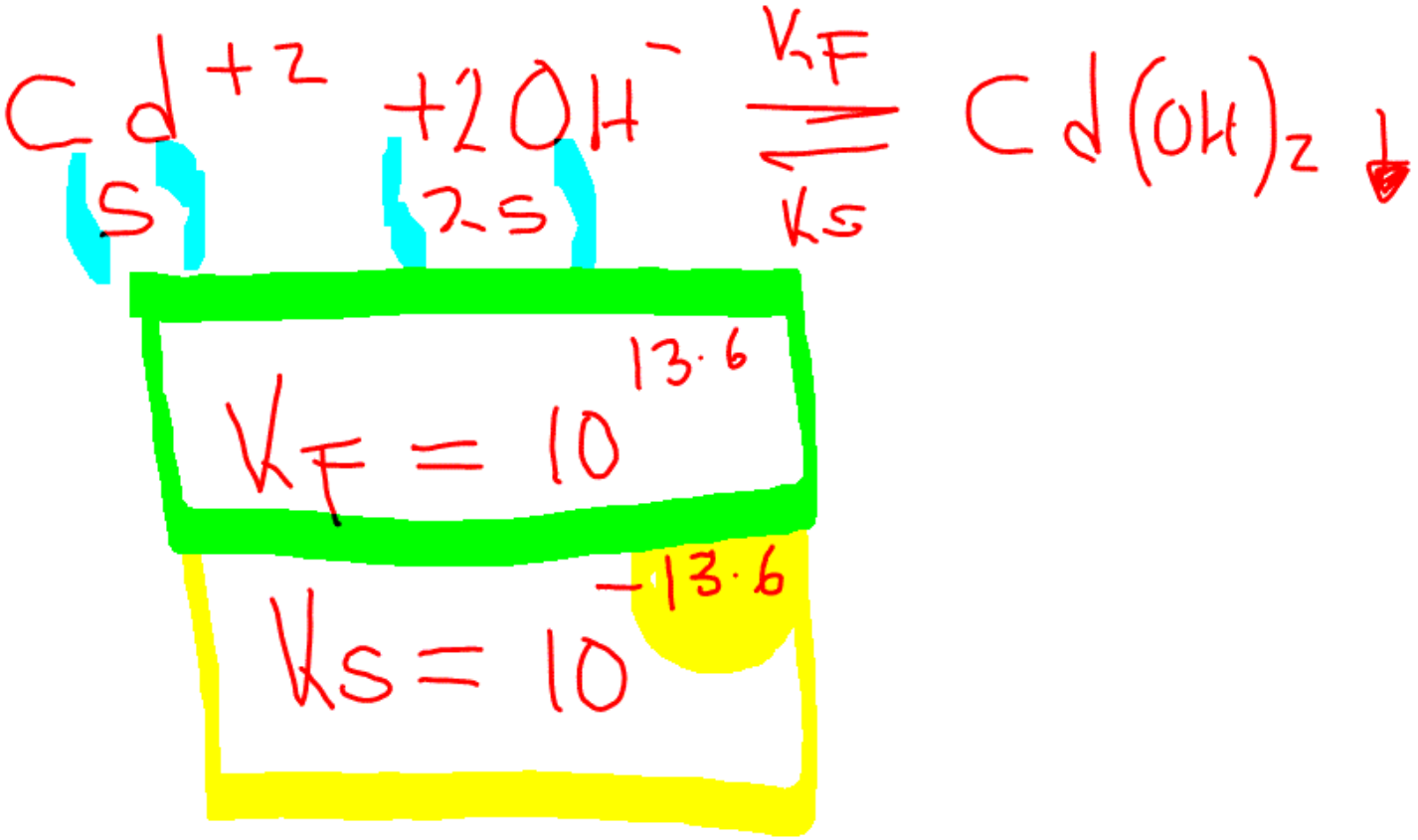
Título de la nota 04/12/2020

$$Cd^{+2} + OH^- \rightleftharpoons [Cd(OH)]^+$$

$$[Cd(OH)]^+ + OH^- \rightleftharpoons [Cd(OH)_2]$$

$$[Cd(OH)_2] + OH^- \rightleftharpoons [Cd(OH)_3]^-$$

$$[Cd(OH)_3]^- + OH^- \rightleftharpoons [Cd(OH)_4]^=$$



$$4s^3 = Ks$$

$$s = \sqrt[3]{\frac{Ks}{4}}$$

pH inicio de pp. $[Cd^{+2}] = 10^{-2}$

$$K_s = [Cd^{+2}][OH^-]^2$$

$$10^{-13.6} = [Cd^{+2}][OH^-]^2$$

$$[OH^-] = \sqrt{\frac{10^{-13.6}}{[Cd^{+2}]}} = \sqrt{\frac{10^{-13.6}}{10^{-2}}}$$

$$[OH^-] = 10^{-11.6/2} = 10^{-5.8}$$

$$pH = 14 + \log [OH^-]$$

$$= 14 + \log 10^{-5.8}$$

$$= 14 - 5.8 = 8.2$$

DATOS | PORTADA

Instrucción: llene los valores en las celdas de color amarillo
En las celdas de color verde aparecen los resultados

Catión	Concentración	pH=	6
Cd^{+2}	0.01		

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	3.7383E+21	5.6234E+22	5.6234E+22
$Cd(OH)_2$	1.9953E+04	5.0119E+07	1.9953E+10	1.0000E+12		

	KML		K_f		pks
Cd-AEDTA	3.16228E+16	Naranja de Xilenol	1.2589E+17	$Cd(OH)_2$	13.6
		Azul de Metiltimol	1E+19		

Indicador	pka_1	pka_2	pka_3	pka4	pka5
Naranja de Xilenol	2.60	3.30	6.40	10.50	12.30
Azul de metiltimol	-30.00	4.50	7.20	11.50	13.40

Nota si tiene un solo valor de pka llene la celda de pka5 y en las demás celdas incluya valores negativos

pH de inicio de precipitación

$Cd(OH)_2$	⟷	Cd^{+2}	2OH

Ks=	$[Cd^{+2}]$	$[OH]^2$	=	2.5119E-14		
$[OH]^2$	=	Ks / $[Cd^{+2}]$	=	2.5119E-14 / 0.01	=	2.51189E-12

[OH]	=	1.58489E-06

pH		8.2

Reacción secundaria pH = 8

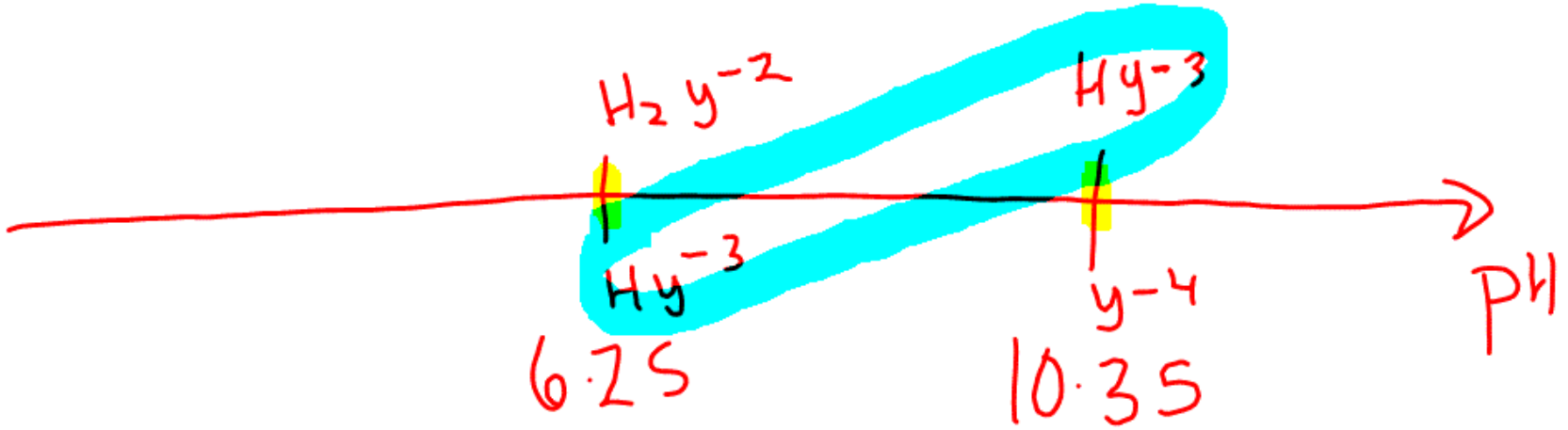
$$\alpha_{Cd(OH^-)} = 1 + \beta_1[OH^-] + \beta_2[OH^-]^2 + \beta_3[OH^-]^3 + \beta_4[OH^-]^4$$

$$[OH^-] = 10^-$$

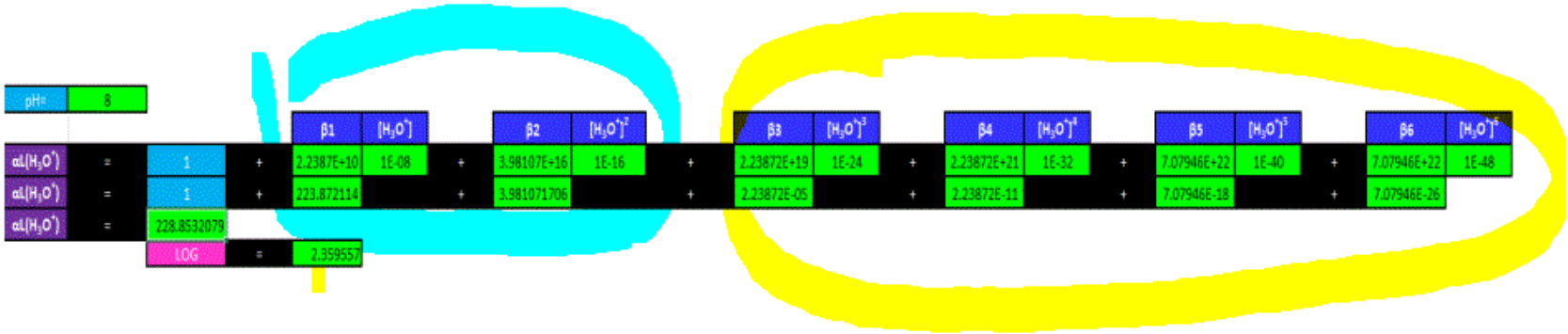
$$=$$

				β1	[OH⁻]		β2	[OH⁻]²		β3	[OH⁻]³		β4	[OH⁻]⁴		β5	[OH⁻]⁵		β6	[OH⁻]⁶
αCd(OH⁻)	=	1	+	19952.6231	1.00E-06	+	50118723.36	1.00E-12	+	19952623150	1E-18	+	1E+12	1E-24	+	0	1E-24	+	0	1E-24
αCd(OH⁻)	=	1	+	0.01995262		+	5.01187E-05		+	1.99526E-08		+	1E-12		+	0		+	0	
αCd(OH⁻)	=	1.020002762																		
		LOG	=	0.00860135																

$$\alpha_{y(H_3O^+)} = 1 + \beta_1[H_3O^+] + \beta_2[H_3O^+]^2 + \beta_3[H_3O^+]^3$$
$$+ \beta_4[H_3O^+]^4 + \beta_5[H_3O^+]^5 + \beta_6[H_3O^+]^6$$



$$Cd^{+2} + Hy^{-3} \rightleftharpoons [CdHy]^-$$



pH=	8																							
				β1	$[H_3O^+]$		β2	$[H_3O^+]^2$		β3	$[H_3O^+]^3$		β4	$[H_3O^+]^4$		β5	$[H_3O^+]^5$		β6	$[H_3O^+]^6$				
$\alpha L(H_3O^+)$	=	1	+	2.2387E+10	1E-08	+	3.98107E+16	1E-16	+	2.23872E+19	1E-24	+	2.23872E+21	1E-32	+	7.07946E+22	1E-40	+	7.07946E+22	1E-48				
$\alpha L(H_3O^+)$	=	1	+	223.872114		+	3.981071706		+	2.23872E-05		+	2.23872E-11		+	7.07946E-18		+	7.07946E-26					
$\alpha L(H_3O^+)$	=	228.8532079																						
		LOG	=	2.359557																				

$$\alpha_{Y(H_3O^+)} = 228.85$$

$$= 10^{2.3595}$$

$$K_F\ Cd(Y) = 10^{16.5}$$

$$K_F' = \frac{K_F}{\alpha_{y(H_3O^+)}\,\alpha_{Cd(OH^-)}}$$

$$= \frac{10^{16.5}}{10^{2.3595}\;10^{0.0086}} = 10^{14.1318}$$

Cuantitividad		
K'ML=	3.16228E+16 / 233.4309042 =	1.355E+14
	LOG =	14.131842

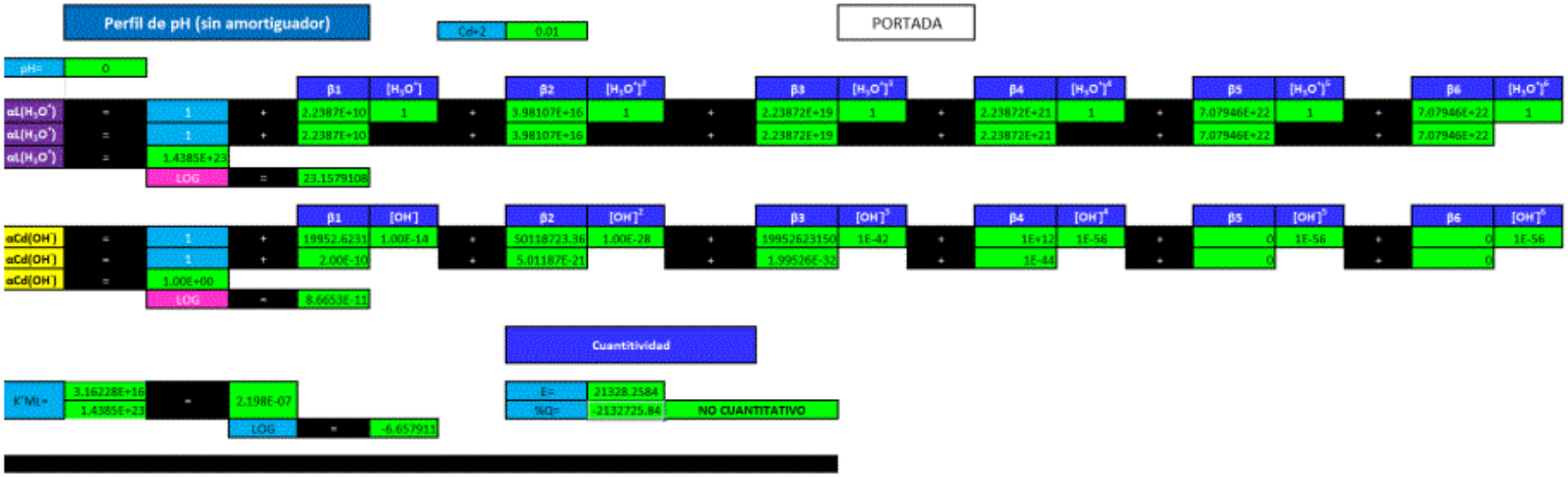
Ɛ=	8.5917E-07	
%Q=	99.9999141	CUANTITATIVO

$$K_F' = \frac{\not{C}_0}{\varepsilon C_0 \varepsilon \not{C}_0}$$

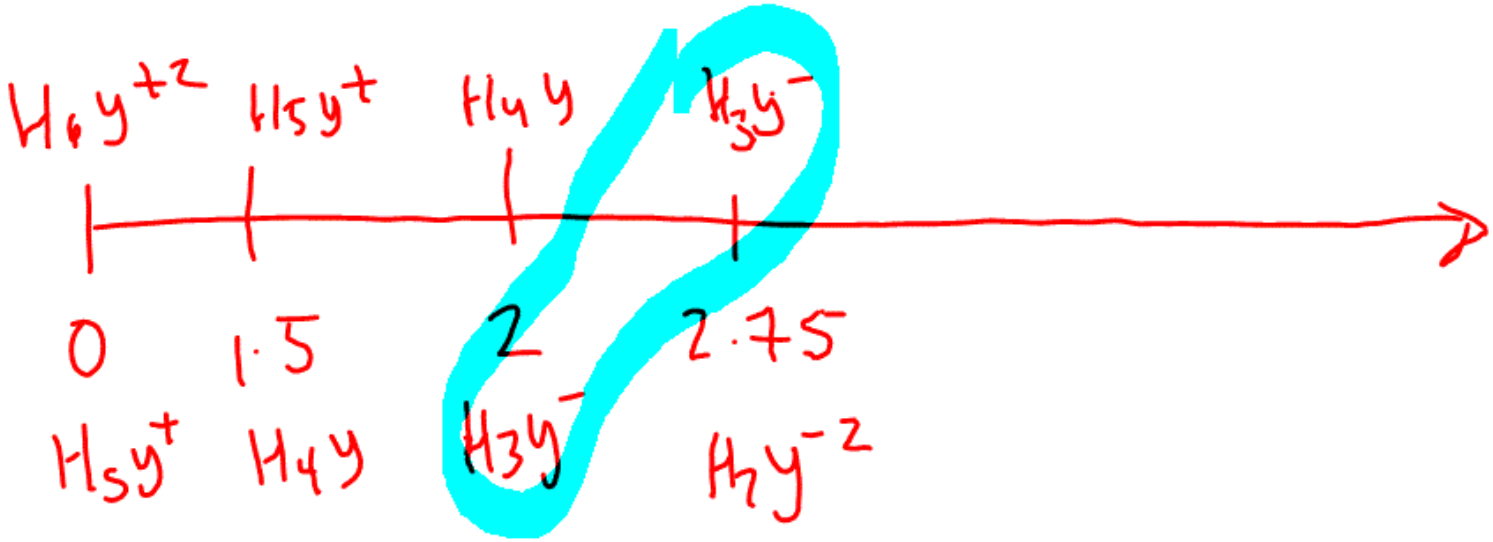
$$\varepsilon = \sqrt{\frac{1}{K_F' C_0}} = \sqrt{\frac{1}{10^{14.1318} \; 10^{-2}}}$$

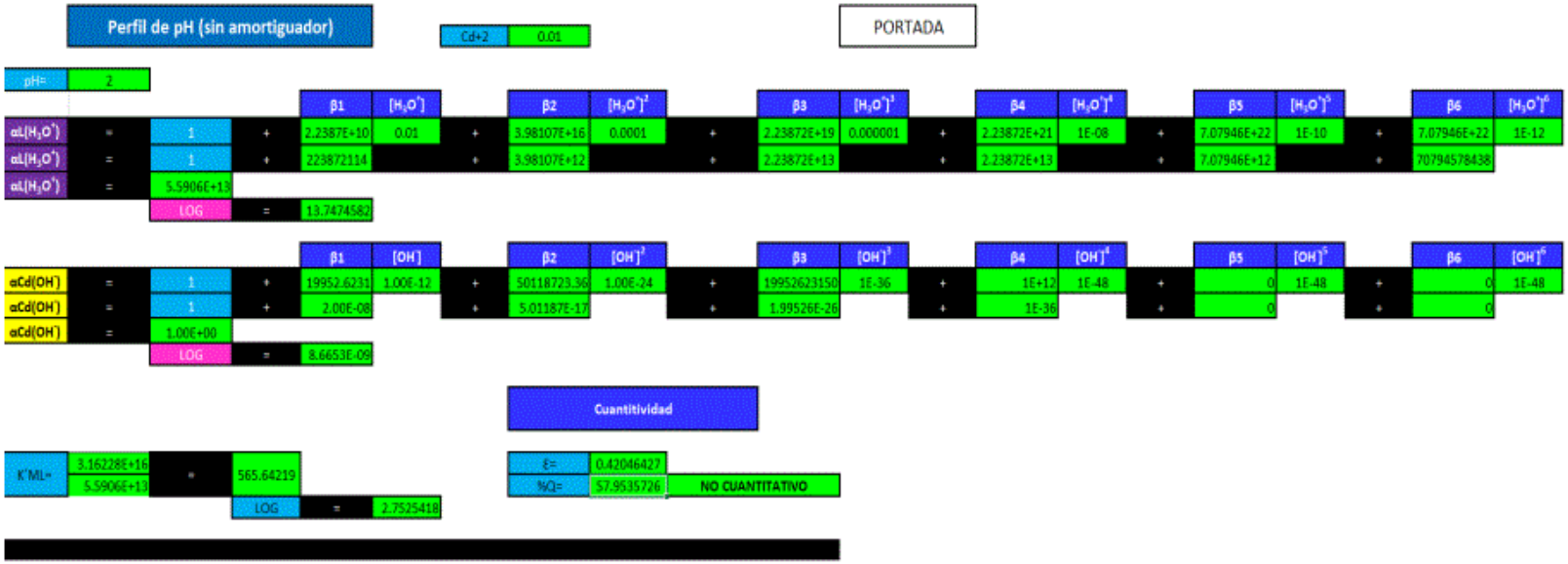
$$\varepsilon = 10^{-12.1318/2} = 10^{-6.065}$$

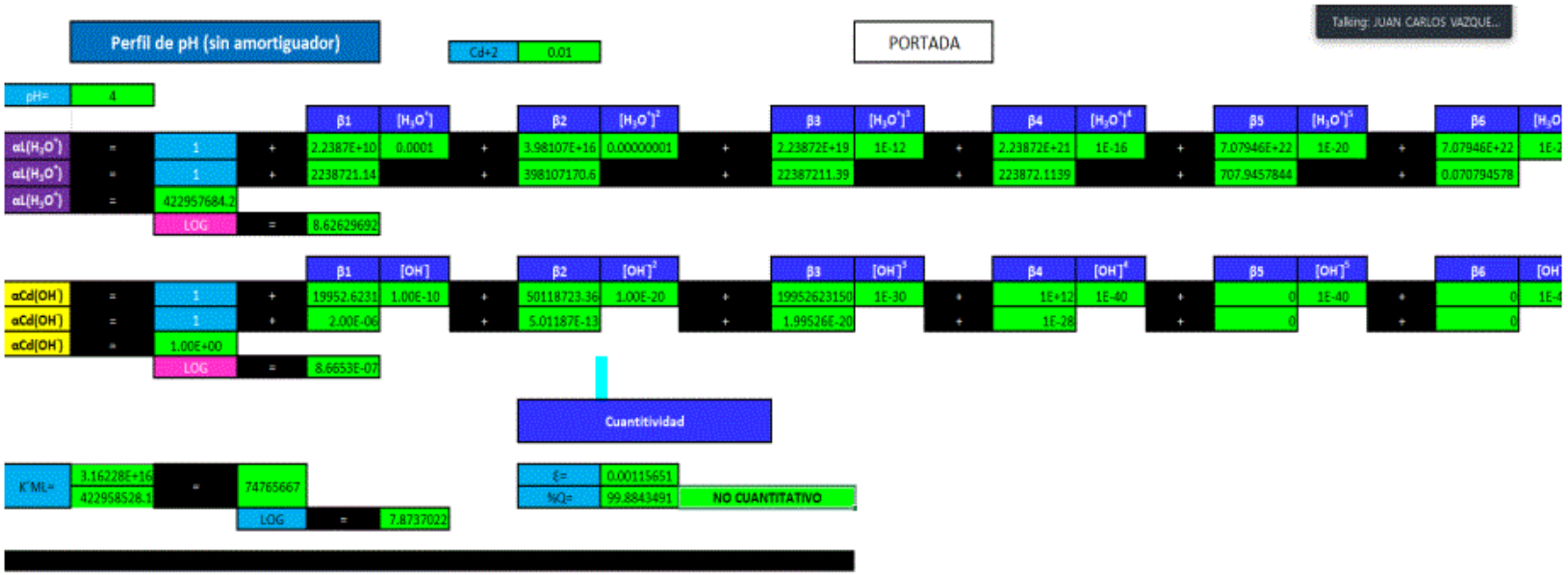
$$\%Q = (1-\varepsilon)100 = 99.99994\%$$

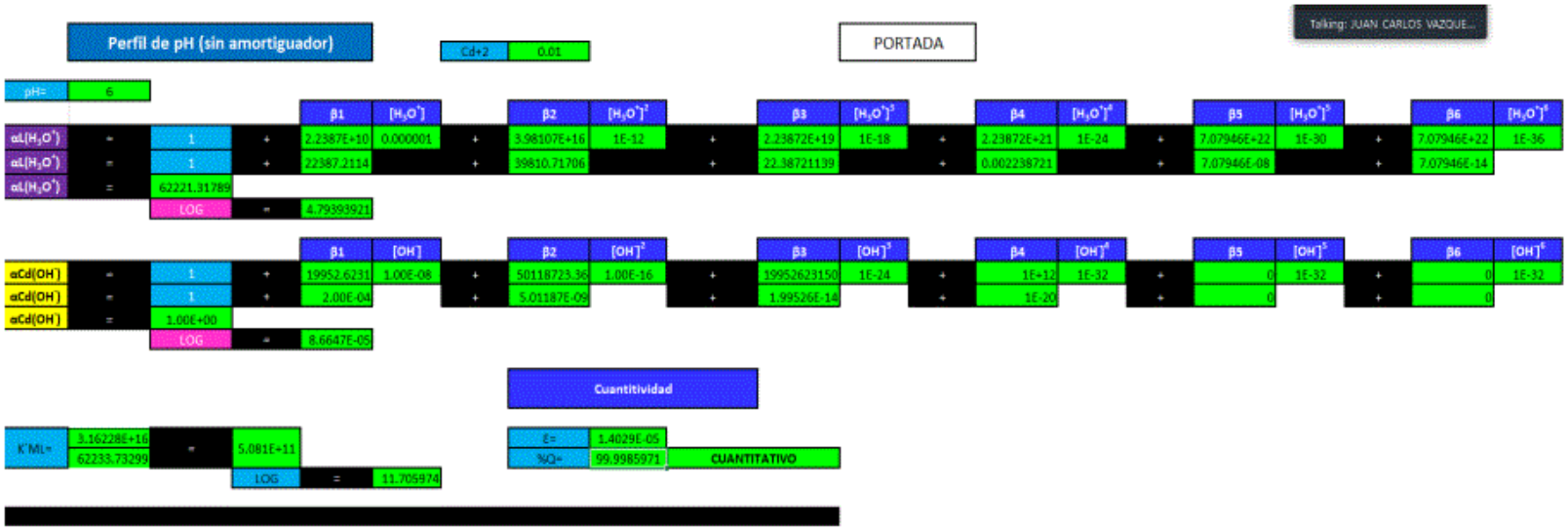


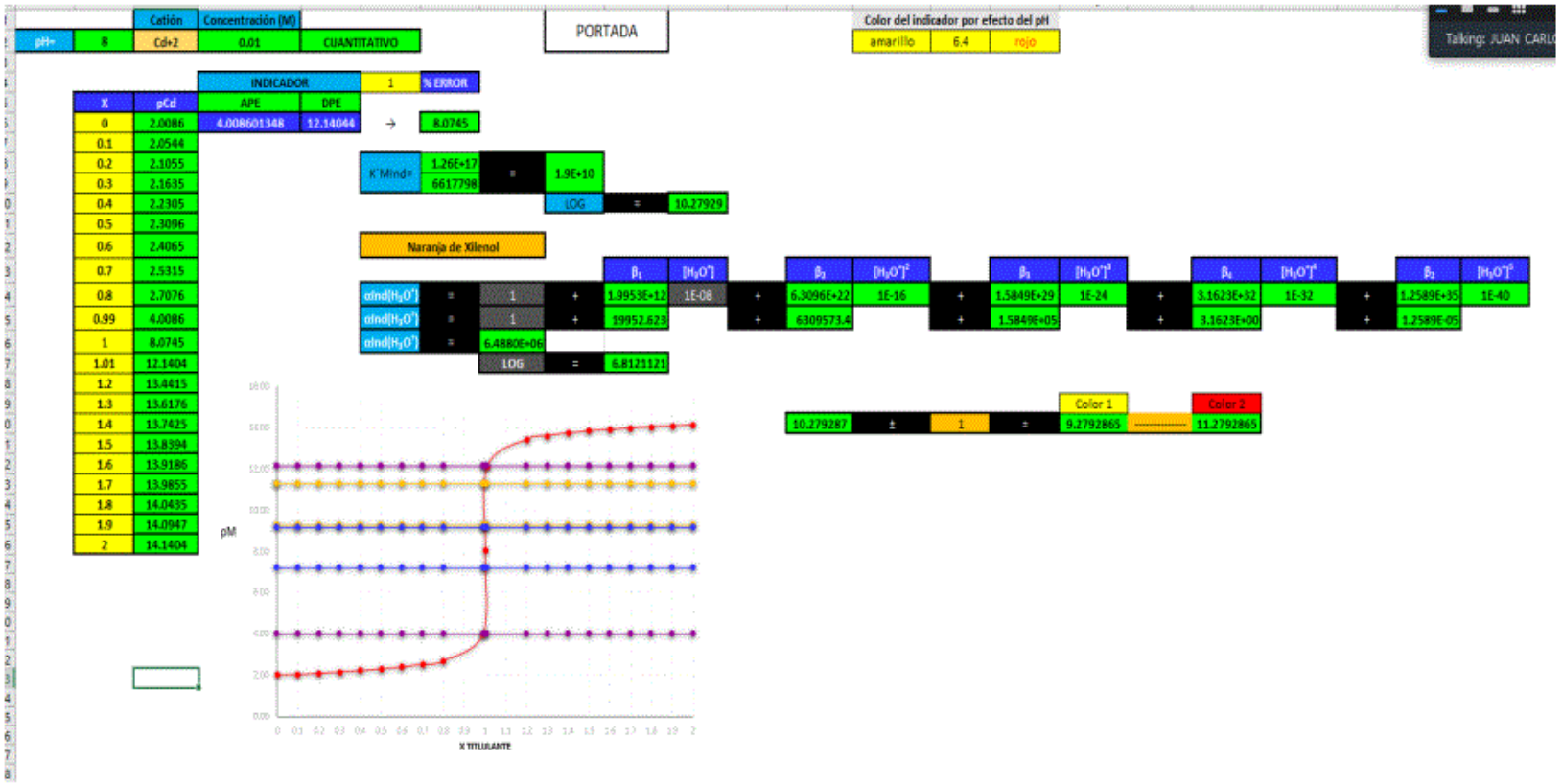
$Cd^{+2} + H_6y^{+2}$ no Rx.


H_6y^{+2}
H_5y^+
H_4y
H_3y^-
0
1.5
2
2.75
H_5y^+
H_4y
H_3y^-
H_2y^{-2}


Perfil de pH (sin amortiguador)
Cd+2 0.01
PORTADA
pH= 2
β1 [H3O+] β2 [H3O+]2 β3 [H3O+]3 β4 [H3O+]4 β5 [H3O+]5 β6 [H3O+]6
αL(H3O+) = 1 + 2.23872E+10 0.01 + 3.98107E+16 0.0001 + 2.23872E+19 0.000001 + 2.23872E+21 1E-08 + 7.07946E+22 1E-10 + 7.07946E+22 1E-12
αL(H3O+) = 1 + 223872114 + 3.98107E+12 + 2.23872E+13 + 2.23872E+13 + 7.07946E+12 + 70794578438
αL(H3O+) = 5.5906E+13
LOG = 13.7474582
β1 [OH-] β2 [OH-]2 β3 [OH-]3 β4 [OH-]4 β5 [OH-]5 β6 [OH-]6
αCd(OH-) = 1 + 19952.6231 1.00E-12 + 50118723.36 1.00E-24 + 19952623150 1E-36 + 1E+12 1E-48 + 0 1E-48 + 0 1E-48
αCd(OH-) = 1 + 2.00E-08 + 5.01187E-17 + 1.99526E-26 + 1E-36 + 0 + 0
αCd(OH-) = 1.00E+00
LOG = 8.6653E-09
Cuantitividad
K'ML= 3.16228E+16 / 5.5906E+13 = 565.64219
LOG = 2.7525418
ξ= 0.42046427
%Q= 57.9535726 NO CUANTITATIVO


Perfil de pH (sin amortiguador)
Cd+2
0.01
PORTADA
Talleng: JUAN CARLOS VAZQUE...
pH=
4
β1
[H3O+]
β2
[H3O+]2
β3
[H3O+]3
β4
[H3O+]4
β5
[H3O+]5
β6
αL(H3O+) = 1 + 2.2387E+10 0.0001 + 3.98107E+16 0.00000001 + 2.23872E+19 1E-12 + 2.23872E+21 1E-16 + 7.07946E+22 1E-20 + 7.07946E+22
αL(H3O+) = 1 + 2238721.14 + 398107170.6 + 22387211.39 + 223872.1139 + 707.9457844 + 0.070794578
αL(H3O+) = 422957684.2
LOG = 8.62629692
β1
[OH-]
β2
[OH-]2
β3
[OH-]3
β4
[OH-]4
β5
[OH-]5
β6
αCd(OH-) = 1 + 19952.6231 1.00E-10 + 50118723.36 1.00E-20 + 19952623150 1E-30 + 1E+12 1E-40 + 0 1E-40 + 0
αCd(OH-) = 1 + 2.00E-06 + 5.01187E-13 + 1.99526E-20 + 1E-28 + 0 + 0
αCd(OH-) = 1.00E+00
LOG = 8.6653E-07
Cuantitividad
K´ML= 3.16228E+16 / 422958528.1 = 74765667
LOG = 7.8737022
ξ= 0.00115651
%Q= 99.8843491
NO CUANTITATIVO


Perfil de pH (sin amortiguador)
Cd+2 0.01
PORTADA
Talking: JUAN CARLOS VAZQUE...
pH= 6
β1 [H3O+] β2 [H3O+]2 β3 [H3O+]3 β4 [H3O+]4 β5 [H3O+]5 β6 [H3O+]6
αL(H3O+) = 1 + 2.2387E+10 0.000001 + 3.98107E+16 1E-12 + 2.23872E+19 1E-18 + 2.23872E+21 1E-24 + 7.07946E+22 1E-30 + 7.07946E+22 1E-36
αL(H3O+) = 1 + 22387.2114 + 39810.71706 + 22.38721139 + 0.002238721 + 7.07946E-08 + 7.07946E-14
αL(H3O+) = 62221.31789
LOG = 4.79393921
β1 [OH] β2 [OH]2 β3 [OH]3 β4 [OH]4 β5 [OH]5 β6 [OH]6
αCd(OH) = 1 + 19952.6231 1.00E-08 + 50118723.36 1.00E-16 + 19952623150 1E-24 + 1E+12 1E-32 + 0 1E-32 + 0 1E-32
αCd(OH) = 1 + 2.00E-04 + 5.01187E-09 + 1.99526E-14 + 1E-20 + 0 + 0
αCd(OH) = 1.00E+00
LOG = 8.6647E-05
Cuantitividad
K'ML= 3.16228E+16 / 62233.73299 = 5.081E+11
LOG = 11.705974
E= 1.4029E-05
%Q= 99.9985971 CUANTITATIVO


PORTADA
Catión
Concentración (M)
pH=
8
Cd+2
0.01
CUANTITATIVO
Color del indicador por efecto del pH
amarillo
6.4
rojo
INDICADOR
1
% ERROR
APE
DPE
4.008601348
12.14044
8.0745
K´Mind=
1.26E+17
6617798
1.9E+10
LOG
10.27929
Naranja de Xilenol
β1
β2
β3
β4
β5
1.9953E+12
1E-08
6.3096E+22
1E-16
1.5849E+29
1E-24
3.1623E+32
1E-32
1.2589E+35
1E-40
19952.623
6309573.4
1.5849E+05
3.1623E+00
1.2589E-05
6.4880E+06
6.8121121
Color 1
Color 2
10.279287
1
9.2792865
11.2792865
pM
X TITULANTE

1.1. DPE

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

$$[Hy^{-3}] = 10^{-4}$$

$$K_F' = \frac{[CdHy]^{-}}{[Cd^{+2}][Hy^{-3}]}$$

$$10^{14.13} = \frac{10^{-2}}{[Cd^{+2}][10^{-4}]}$$

$$[Cd^{+2}]$$

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

$$[Cd^{+2}] = \frac{\frac{10^{2}}{10^{14.B}}}{\alpha\, Cd(OH)} = \frac{10^{-12.B}}{10^{0.0086}}$$

$$\left[[Cd^{+2}] = 10^{-12.13086}\right] - \log$$

$$pCd = 12.13$$

pM transición

$$pM = KF'_{Cd(Ind)} \pm 1$$

$$KF'_{Cd(Ind)} = KF\,Cd(Ind)$$

$$\alpha_{Ind(H_3O^+)}\ \alpha_{Cd(OH^-)}$$

Naranja de Xilenol				β_1	$[H_3O^+]$		β_2	$[H_3O^+]^2$		β_3	$[H_3O^+]^3$		β_4	$[H_3O^+]^4$		β_5	$[H_3O^+]^5$
$\alpha Ind[H_3O^+]$	=	1	+	1.9953E+12	1E-08	+	6.3096E+22	1E-16	+	1.5849E+29	1E-24	+	3.1623E+32	1E-32	+	1.2589E+35	1E-40
$\alpha Ind[H_3O^+]$	=	1	+	19952.623		+	6309573.44		+	1.5849E+05		+	3.1623E+00		+	1.2589E-05	
$\alpha Ind[H_3O^+]$	=	6.4880E+06															
		LOG	=	6.8121121													

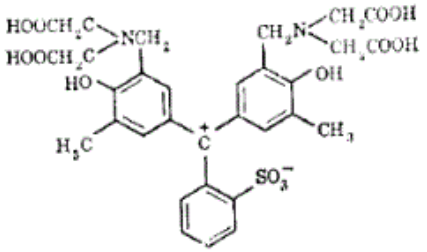
INDICADOR		1	% ERROR
APE	DPE		
4.0086E+00	1.21404E+01	→	8.0745

K´MInd=	1.259E+17 / 6617797.9	=	1.902E+10		
			LOG	=	10.279287

					Color 1		Color 2
10.2792865	±	1	=		9.2792865	----------	11.2792865

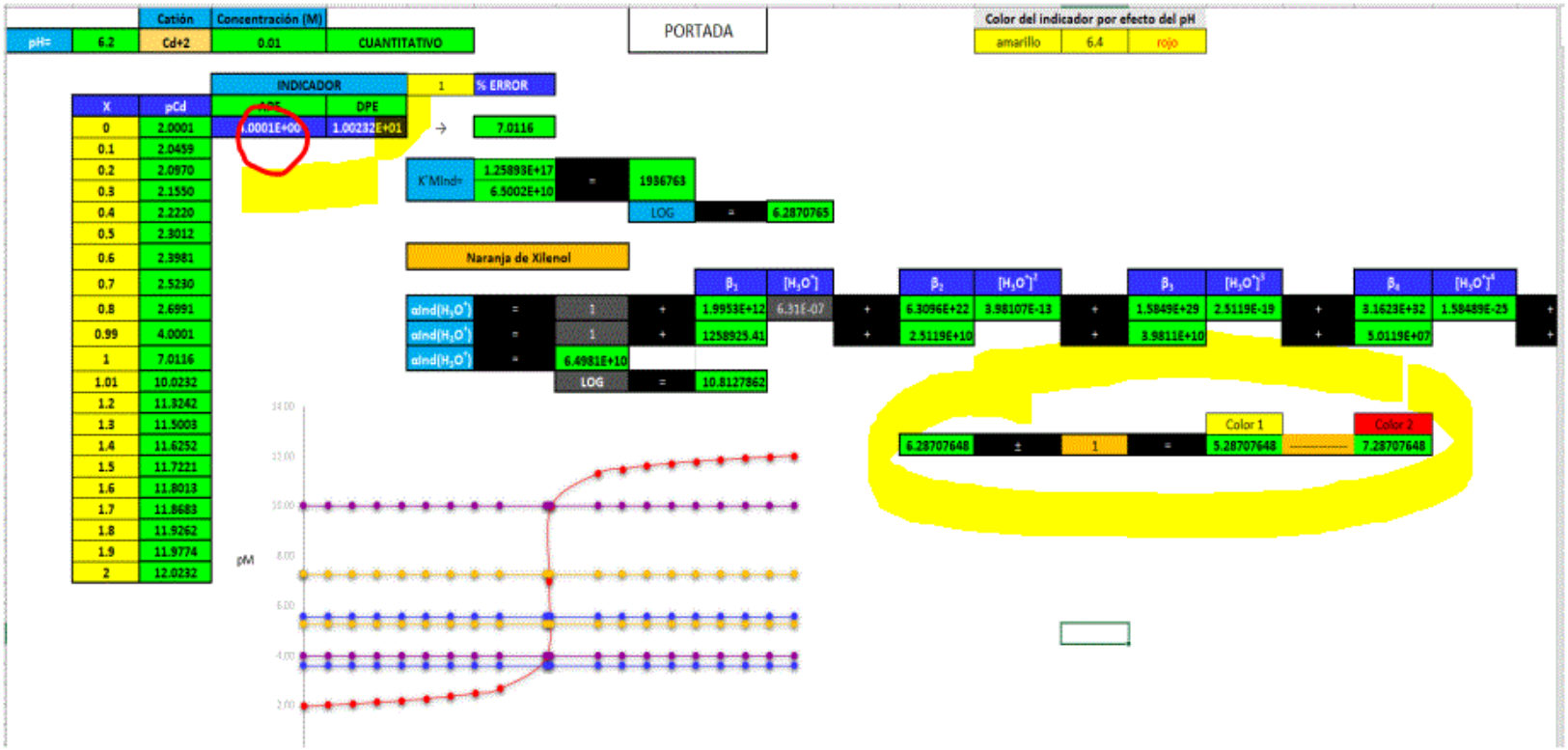
TABLA A.7 *(Cont.)*

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 logarítmicas: 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))



X	pCd
0	2.0001
0.1	2.0459
0.2	2.0970
0.3	2.1550
0.4	2.2220
0.5	2.3012
0.6	2.3981
0.7	2.5230
0.8	2.6991
0.99	4.0001
1	7.0116
1.01	10.0232
1.2	11.3242
1.3	11.5003
1.4	11.6252
1.5	11.7221
1.6	11.8013
1.7	11.8683
1.8	11.9262
1.9	11.9774
2	12.0232

$$NH_3(g) + H_2O \rightleftharpoons NH_4OH_{(ac)}$$

$$Cd^{+2} + NH_3 \rightleftharpoons [Cd(NH_3)]^{+2}$$

$$\cdots [Cd(NH_3)_6]^{+2}$$

$$Cd^{+2} + NH_4^{+} \rightleftharpoons \text{no Rx}$$

$$K_F' = \frac{K_F}{\alpha_{Cd(OH,SCN^-)}\,\alpha_{Y(H_3O^+)}}$$

$$\alpha_{Cd(OH)} =$$

$$\alpha_{Cd(SCN)} =$$

$$\alpha_{Cd(OH,SCN^-)} = \alpha_{Cd(OH)} + \alpha_{Cd(NH_3)} - (n-1)$$

$$n = 2$$

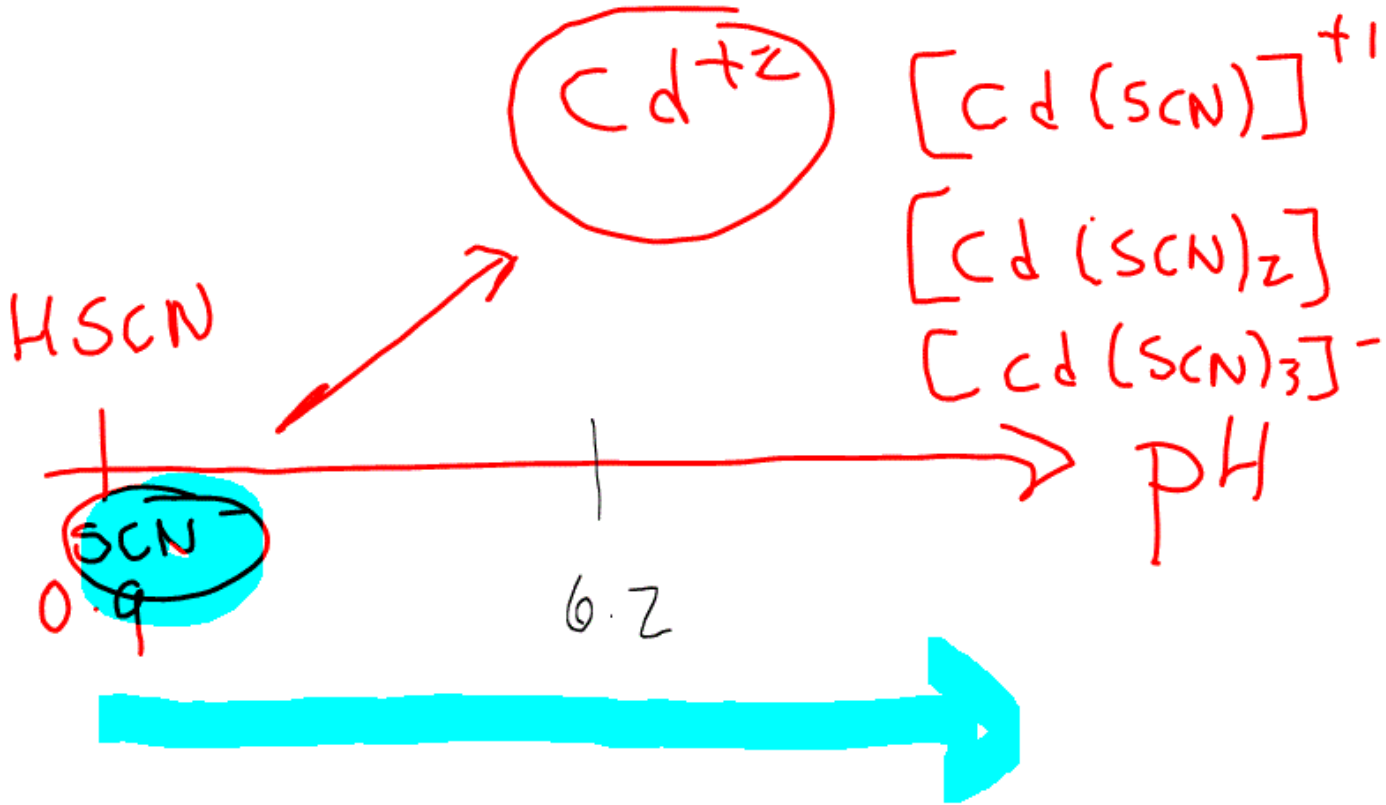
$\alpha_{y(H_3O^+)}$

Cd^{+2} ← Al^{+3}

$\alpha_{y(Al^{+3})} =$ $\alpha_{y(H_3O^+)} =$

$$\alpha_{y(H_3O^+)} + \alpha_{y(Al^{+3})} - (Z-1)$$

$n = 2$


Cd^{+2}
$[Cd(SCN)]^{+1}$
$[Cd(SCN)_2]$
$[Cd(SCN)_3]^-$
HSCN
pH
SCN^-
0.9
6.2