I type Prigogine absolute energy attractors of electrodes metals Fe, Cu, Zn, Cr immersed in a solution of ions.
Prigogine absolute energy attractors for dissolution, protolysis, and reduction-oxidation of iron compounds.

$Fe_{(s)}+H_2O=Fe^{2+}+\mathbf{2e^-}$;

$E_{Fe}=E°_{Fe/Fe2+}+0,0591/2*\log([Fe^{2+}]/[Fe]/([H_2O]))=\mathbf{-0,66623}+0,0591/2*\log(0,1/1/(55,3))=-0,74728$ V;

Distinguish from -0,74728 V is on 4th digit -0,74739 V.

$E_{Fe}=E°_{Fe/Fe2+}+0,0591/2*\log([Fe^{2+}]/[Fe]/([H_2O]-6[Fe^{2+}]))=\mathbf{-0,66623}+0,0591/2*\log(0,1/1/(56,38-0,6))=-0,74739$ V;

$[H_2O]=55,3$ M=996 $^g/_L$/18$^g/_{mol}$; $m_{H2O}=m_L-m_{FeSO4}=1030-15,191=1014,8$ g; $[H_2O]=1014,8\ ^g/18\ ^g/_{mol}=56,38$ M.

Formation Fe $+O_2{}^{gas}+H_2{}^{gas}=Fe(OH)_2$;

$\Delta G°_{form}=G_{Fe(OH)2}-(G_{Fe(}+G_{O2}{}^{gas}+G_{H2}{}^{gas})=\mathbf{39,349}-(\mathbf{140,609}+\mathbf{303,1}+\mathbf{85,64})=-490\ ^{kJ}/_{mol}$; [37]

$G_{Fe(OH)2}=\Delta G°_{form}+(G_{Fe}+G_{O2}{}^{gas}+G_{H2}{}^{gas})=-490+(\mathbf{140,609}+\mathbf{303,1}+\mathbf{85,64})=\mathbf{39,349}\ ^{kJ}/_{mol}$;

Formation Fe $+1,5O_2{}^{gas}+1,5H_2{}^{gas}=Fe(OH)_3$;

$\Delta G°_{form}=G_{Fe(OH)3}-(G_{Fe(}+1,5G_{O2}{}^{gas}+1,5G_{H2}{}^{gas})=\mathbf{27,119}-(\mathbf{140,609}+1,5*\mathbf{303,1}+1,5*\mathbf{85,64})=-696,6\ ^{kJ}/_{mol}$; [33]

$G_{Fe(OH)3}=\Delta G°_{form}+(G_{Fe}+G_{O2}{}^{gas}+G_{H2}{}^{gas})=-696,6+(\mathbf{140,609}+1,5*\mathbf{303,1}+1,5*\mathbf{85,64})=\mathbf{27,119}\ ^{kJ}/_{mol}$;

[1] Solubility $Fe(OH)_2+3H_2O=Fe^{2+}+2OH^-$; $K_{sp}=\mathbf{[Fe^{2+}]*[OH^-]^2}/[H_2O]^3=4,87*10^{(-17)}/55,3^3=10^{(-21,54)}$;

Attractor $\Delta\mathbf{G}_{sp}=-RTln(\mathbf{K}_{speq})=-8,3144*298,15*\ln(10^{(-21,54)})=\mathbf{122,95}\ ^{kJ}/_{mol}$

$\Delta G_{sp}=G_{Fe2+}+2G_{OH-}-(G_{Fe\ (OH)2}+3G_{H2O})=G_{Fe2+}+2*\mathbf{77,36}-(\mathbf{24,72}+3*\mathbf{0})=\mathbf{122,95}\ ^{kJ}/_{mol}$;

$G_{Fe2+}=\Delta G_{sp}-2G_{OH-}+(G_{Fe(OH)2}+3G_{H2O})=\mathbf{122,95}-2*\mathbf{77,36}+(\mathbf{24,72}+3*\mathbf{0})=\mathbf{12,04855}\ ^{kJ}/_{mol}$;

[1] Solubility $Fe(OH)_3+4H_2O=Fe^{3+}+3OH^-$; $K_{sp}=\mathbf{[Fe^{3+}]*[OH^-]^3}/[H_2O]^4=2,79*10^{(-39)}/55,3^4=10^{(-44,369)}$;

Attractor $\Delta\mathbf{G}_{sp}=-RTln(\mathbf{K}_{speq})=-8,3144*298,15*\ln(10^{(-44,369)})=\mathbf{259,855}\ ^{kJ}/_{mol}$;

$\Delta G_{sp}=G_{Fe3+}+3G_{OH-}-(G_{Fe(OH)3}+4G_{H2O})=\mathbf{40,2605}+3*\mathbf{77,36}-(\mathbf{12,4855}+4*\mathbf{0})=\mathbf{259,855}\ ^{kJ}/_{mol}$;

$G_{Fe(OH)3}=G_{Fe3+}+3G_{OH-}-(\Delta G_{sp}+4G_{H2O})=\mathbf{40,2605}+3*\mathbf{77,36}-(\mathbf{259,855}+4*\mathbf{0})=\mathbf{12,4855}\ ^{kJ}/_{mol}$;

$G_{Fe3+}=\Delta G_{sp}-3G_{OH-}+(G_{Fe(OH)3}+4G_{H2O})=\mathbf{259,855}-3*\mathbf{77,36}+(\mathbf{12,4855}+4*\mathbf{0})=\mathbf{40,2605}\ ^{kJ}/_{mol}$;

[1] Acid $\mathbf{H}CO_3^-+H_2O=\mathbf{H_3O^+}+CO_3^{2-}$; $K_{prot}=K_a/[H_2O]=\mathbf{[H_3O^+]*[}CO_3^{2-}\mathbf{]}/[H_2O]/[\mathbf{H}CO_3^-]=10^{(-10,33)}/55,3=10^{(-12,073)}$;

Attractor $\Delta\mathbf{G}_{prot}=-RTln(\mathbf{K}_{prot})=-8,3144*298,15*\ln(10^{(-12,073)})=\mathbf{68,9123}\ ^{kJ}/_{mol}$;

$\Delta G_{prot}=G_{\mathbf{H3O}+}+G_{CO32-}-(G_{\mathbf{H}CO3-}+G_{H2O})=\mathbf{22,44}+\mathbf{102,55}-(\mathbf{56,08}+\mathbf{0})=\mathbf{68,9123}\ ^{kJ}/_{mol}$;

$G_{CO32}=\Delta G_{prot}-G_{\mathbf{H3O}+}+(G_{\mathbf{H}CO3-}+G_{H2O})=\mathbf{68,9123}-\mathbf{22,44}+(\mathbf{56,08}+\mathbf{0})=\mathbf{102,5523}\ ^{kJ}/_{mol}$;

[1[Solubility $FeCO_3^{2-}+2H_2O=Fe^{2+}+CO_3^{2-}$; $K_{sp}=[Fe^{2+}]*[CO_3^{2-}]^3/[H_2O]^2=3,13*10^{(-11)}/55,3^2=10^{(-13,99)}$;

Attractor $\Delta\mathbf{G}_{sp}=-RTln(\mathbf{K}_{speq})=-8,3144*298,15*\ln(10^{(-13,99)})=\mathbf{79,8545}\ ^{kJ}/_{mol}$;

$\Delta G_{sp}=G_{Fe3+}+G_{CO32-}-(G_{FeCO3}+2G_{H2O})=\mathbf{60,31655}+\mathbf{102,55}-(G_{FeCO3}+2*\mathbf{0})=\mathbf{79,8545}\ ^{kJ}/_{mol}$;

$G_{FeCO3}=G_{Fe3+}+G_{CO32-}-(\Delta G_{sp}+2G_{H2O})=\mathbf{60,31655}+\mathbf{102,55}-(\mathbf{79,8545}+2*\mathbf{0})=\mathbf{83,01205}\ ^{kJ}/_{mol}$;

Formation $\Delta G°_{form}=G_{FeCO3}-(G_{Fe(}+1,5G_{O2}{}^{gas}+G_{Cgraph})=\mathbf{19,819}-(\mathbf{140,609}+1,5*\mathbf{303,1}+\mathbf{91,26})=-666,7\ ^{kJ}/_{mol}$; [33]

$G_{FeCO3}=\Delta G°_{form}+(G_{Fe}+1,5G_{O2}{}^{gas}+G_{Cgraph})=-666,7+(\mathbf{140,609}+1,5*\mathbf{303,1}+\mathbf{91,26})=\mathbf{19,819}\ ^{kJ}/_{mol}$;

Formation Fe $+1,5O_2{}^{gas}+C_{graph}=FeCO_3$; $1,5O_2{}^{gas}+C_{graph}=CO_3^{2-}$; $1,5O_2{}^{gas}+0,5H_2{}^{gas}+C_{graph}+G_{e-}=\mathbf{H}CO_3^-$;

$\Delta G°_{form}=G_{CO32-}-(1,5G_{O2}{}^{gas}+G_{Cgraph}+2G_{e-})=\mathbf{102,5523}-(1,5*\mathbf{303,1}+\mathbf{91,26}+2*\mathbf{42,2212})=-527,8\ ^{kJ}/_{mol}$; [1]

$G_{e-}=(G_{CO32-}-(1,5G_{O2}{}^{gas}+G_{Cgraph}+\Delta G°_{form}))/2=(\mathbf{102,5523}-(1,5*\mathbf{303,1}+\mathbf{91,26}-527,8))/2=\mathbf{42,2212}\ ^{kJ}/_{mol}$; [1]

$\Delta G°_{form}=G_{HCO3-}-(1,5G_{O2}+G_{Cgr}+0,5G_{H2}+G_{e-})=\mathbf{56,08}-(1,5*\mathbf{303,1}+\mathbf{91,26}+0,5*\mathbf{85,64}+\mathbf{54,15})=-586,8\ ^{kJ}/_{mol}$; [1]

$G_{e-}=G_{HCO3-}-(1,5G_{O2}+G_{Cgr}+0,5G_{H2}+\Delta G°_{form})=\mathbf{56,08}-(1,5*\mathbf{303,1}+\mathbf{91,26}+0,5*\mathbf{85,64}-586,8)=\mathbf{54,15}\ ^{kJ}/_{mol}$;

Formation [1] $Fe_{(s)}=Fe^{3+}+\mathbf{3e^-}$; $G_{e-}=(G_{Fe}-(G_{Fe3+}+\Delta G°))/3=(\mathbf{139,45}-(\mathbf{60,3136}+(-4,7)))/3=\mathbf{27,9455}\ ^{kJ}/_{mol}$;

Formation [8] $Fe_{(s)}=Fe^{3+}+\mathbf{3e^-}$; $G_{e-}=(G_{Fe}-(G_{Fe3+}+\Delta G°))/3=(\mathbf{139,45}-(\mathbf{60,3136}+(\mathbf{-11,99})))/3=\mathbf{30,376}\ ^{kJ}/_{mol}$;

Iron(II) Metal iron $Fe_{(s)}+H_2O=Fe^{2+}+\mathbf{2e^-}$ $[FeSO_4]=0,1$ M solution mas $FeSO_4=15,191$ g, density 1,03 $^g/_{mL}$.

$Fe_{(s)}+H_2O=Fe^{2+}+\mathbf{2e^-}$; $E°_{classic}=-0,447$ V [1], water logarithm 0,0515 and sum $\Delta E°$:

$E°_{Fe/Fe2+}=E°_{classic}-0,0591/2*\log(1/[H_2O]^1)+\Delta E°=-0,447-0,0591/2*\log(1/55,3)+0,10166-0,37239=\mathbf{-0,66623}$ V.

$\Delta\mathbf{G}_{eq}=E°_{Fe}\bullet F\bullet 2=\mathbf{-0,66623}*96485*2=\mathbf{-128,56}\ ^{kJ}/_{mol}$,

$\Delta\mathbf{G}_{eq}=G_{Fe2+}+2G_{e-}-(G_{Fe}+\mathbf{G_{H2O}})=\mathbf{12,049}+2*\mathbf{0,0}-(\mathbf{140,609}+\mathbf{0})=\mathbf{-128,56}\ ^{kJ}/_{mol}$;

$G_{e-}=(\Delta\mathbf{G}_{eq}-G_{Fe2+}+(G_{Fe}+\mathbf{G_{H2O}}))/2=(\mathbf{-128,56}-\mathbf{12,049}+(\mathbf{140,609}+\mathbf{0}))/2=\mathbf{0,0}\ ^{kJ}/_{mol}$;

$G_{Fe}=G_{Fe2+}+2G_{e-0}-(\Delta\mathbf{G}_{eq}+\mathbf{G_{H2O}})=\mathbf{12,049}+2*\mathbf{0}-(\mathbf{-128,56}+\mathbf{0})=\mathbf{140,6}\ ^{kJ}/_{mol}$;

$G_{Fe2+}=\Delta\mathbf{G}_{eq}-2G_{e-}+(G_{Fe}+\mathbf{G_{H2O}})=\mathbf{-128,56}-2*\mathbf{0,0}+(\mathbf{140,609}+\mathbf{0})=\mathbf{12,04855}\ ^{kJ}/_{mol}$;

Iron(II) $Fe_{(s)}+2H_2O=Fe(OH)^++H_3O^++\mathbf{2e^-}$ $[FeSO_4]=0,1$ M solution mas $FeSO_4=15,191$ g, density 1,03 $^g/_{mL}$.

$Fe_{(s)}+2H_2O=Fe(OH)^++H_3O^++\mathbf{2e^-}$; $E°_{classic}=-0,447$ V [1], water logarithm 0,102995 and sum $\Delta E°$:

$E°_{Fe/Fe(OH)+}=E°_{classic}-0,0591/2*\log(1/[H_2O]^2)+\Delta E°=-0,447+0,102995+0,10166-0,37239=\mathbf{-0,614735}$ V.

$\Delta\mathbf{G}_{eq}=E°_{Fe}\bullet F\bullet 2=\mathbf{-0,614735}*96485*2=\mathbf{-118,625}\ ^{kJ}/_{mol}$,

$\Delta\mathbf{G}_{eq}=G_{Fe(OH)+}+G_{H3O+}+2G_{e-}-(G_{Fe}+\mathbf{2G_{H2O}})=\mathbf{38,02755}+\mathbf{22,44}+2*\mathbf{0}-(\mathbf{140,609}+2*\mathbf{0})=\mathbf{-118,625}\ ^{kJ}/_{mol}$;

$G_{e-}=(\Delta\mathbf{G}_{eq}-G_{Fe(OH)+}+(G_{Fe}+\mathbf{G_{H2O}}))/2=(\mathbf{-118,625}-\mathbf{38,02755}-\mathbf{22,44}+(\mathbf{140,609}+2*\mathbf{0}))/2=\mathbf{-19,2418}\ ^{kJ}/_{mol}$; Wrong!

$G_{Fe}=G_{Fe(OH)+}+2G_{e-0}-(\Delta\mathbf{G}_{eq}+\mathbf{G_{H2O}})=\mathbf{38,02755}+\mathbf{22,44}+2*\mathbf{-19,2418}-(\mathbf{-118,625}+2*\mathbf{0})=\mathbf{140,609}\ ^{kJ}/_{mol}$;

$G_{Fe(OH)+}=\Delta\mathbf{G}_{eq}-2G_{e-}+(G_{Fe}+\mathbf{G_{H2O}})=\mathbf{-118,625}-\mathbf{22,44}-2*\mathbf{0}+(\mathbf{140,609}+2*\mathbf{0})=\mathbf{38,0276}\ ^{kJ}/_{mol}$;

Iron(III) $Fe_{(s)}+3H_2O=[Fe(OH)_2]^{+}+2H_3O^{+}+3e^{-}$; potential has $E°_{classic}$=-0,037 V [1], water log 0,102995 and ΔE°:

$E°_{Fe/FeOH2+}=E°_{classic}-0{,}0591/3*\log(1/[H_2O]^3)+ΔE°=-0{,}037-0{,}0591/3*\log(1/55{,}3^{\wedge 3})+0{,}10166-0{,}37239=$**-0,204735** V

$ΔG_{eq}=E°_{Fe/[Fe(OH2]+}•F•3=$**-0,204735**$*96485*3=$**-59,2616** kJ/mol,

$ΔG_{eq}=G_{[Fe(OH)2]+}+2G_{H3O+}+3G_{e-}-(G_{Fe(s)}+3G_{H2O})=$**47,8715**$+2*$**22,44**$+3*$**-4,1877**$-($**139,45**$+3*$**0**$)=$**-59,2616** kJ/mol;

$3G_{e-}=ΔG_{eq}-G_{[Fe(OH)2]+}-2G_{H3O+}+(G_{Fe(s)}+3G_{H2O})=$**-59,2616-47,8715**$-2*$**22,44**$+($**139,45**$+3*$**0**$)=3*$**-4,1877** kJ/mol;

$G_{Fe(s)}=G_{[Fe(OH)2]+}+2G_{H3O+}+3G_{e-}-(ΔG_{eq\_Fe}+G_{H2O})=$**47,8715**$+2*$**22,44**$+3*$**-4,1877**$-($**-59,2616**$+3*0)=$**139,45** kJ/mol;

$G_{[Fe(OH)2]+}=ΔG_{eq}-2G_{H3O+}-3G_{e-}+(G_{Fe(s)}+G_{H2O})=$**-59,2616**$-2*$**22,44**$-3*$**-4,1877**$+($**139,45**$+3*0)=$**47,8715** kJ/mol;

Substance	$ΔH°_H$ kJ/mol	$ΔS°_H$ J/mol/K	$ΔG°_H$, kJ/mol
Fe-	$E°_{Fe2+}$=	**-0,66623**	**140,609**
Fe	$E°_{Fe3+}$=	**-0,273398**	**139,45**
[8] Fe^{2+}	**-87,45**	**-17,8**	**-82,14**
[1] Fe^{2+}	-89,1	-137,7	-78,9
G_{e-}-Fe^{2+}	[1] Free e-	-78,9	**103,73**
Fe^{2+}	$E°_{Fe2+/Fe3+}$=	**0,50027** V	**12,04855**
Fe^{2+}	K_{sp}=	$10^{-24,886}$	**12,04855**
$Fe(OH)_2$	$G_{Fe(OH)2}$=	**39,349**	-490
[8] Fe^{3+}	**-44,79**	**-110**	**-11,99**
G_{e-}-Fe^{3+}	[8] Free e-	**-11,99**	**30,376**
[1] Fe^{3+}	-48,5	-315,9	-4,7
G_{e-}-Fe^{3+}	[1] Free e-	-4,7	**27,9455**
Fe^{3+}	$E°_{Fe3/Fe2+}$ V	**-0,50027**	**56,2755**
Fe^{3+}	K_{sp}=	$=10^{-44,369}$	**40,2605**
$Fe(H_2O)^{3+}$	K_a=	$=10^{-4,2027}$	**60,31655**
$[Fe(OH)]^{+}$	-324,7	-29	-277,4
$[Fe(OH)]^{+}$	G_{e-}-format	-277,4	**18,39245**
$[Fe(OH)]^{+}$	$K_a/[H_2O]$=	$10^{\wedge(-8,4827)}$	**38,02755**
$Fe(OH)^{2+}$	-290,8	-142,0	-229,4
$Fe(OH)^{2+}$	G_{e-}-format	-229,4	**21,2773**
$Fe(OH)^{2+}$	$K_a/[H_2O]$=	$10^{\wedge(-4,2027)}$	**61,86545**
$Fe(OH)^{2+}$	$ß_1=10^{\wedge 11,81}$	$10^{\wedge(-4,2027)}$	**60,3182**
$Fe(OH)_2^{+}$	$ß_2=10^{\wedge 22,32}$	$=10^{25,80545}$	**67,74**
$Fe(OH)_2^{+}$	$K_a/[H_2O]^2$=	$10^{\wedge(-5,6824)}$	**47,8715**
$Fe(OH)_2^{+}$	format G_{e-}	-438,0	**42,3185**
$Fe(OH)_3$	-823	107	-696,6
$Fe(OH)_3$	Formation	-696,6	**27,119**
$Fe(OH)_3$	K_{sp}=	$=10^{-44,369}$	**12,4855**
$FeCO_3$	-740,6	92,88	-666,7
$FeCO_3$	Formation	-666,7	**19,819**
$FeCO_3$	K_{prot}=	$10^{-13,99}$	**83,01205**
CO_3^{2-}	-677,1	-56,9	-527,8
G_{e-}-CO_3^{2-}	Formation	-527,8	**42,2212**
CO_3^{2-}	K_{prot}=	$10^{-12,073}$	**102,5523**
HCO_3^{-}	-692,0	91,2	-586,8
G_{e-}-**HCO_3^{-}**	Formation	-586,8	**54,15**
H_3O^{+}	**HCO_3^{-}**	**22,44**	**56,08**
H_3O^{+}	OH^{-}	**22,44**	**77,36**

$G_{O2}^{gas}=$**303,1** kJ/mol; $G_{H2}^{gas}=$**85,64** kJ/mol; $G_{Cgraph}=$**91,26** kJ/mol;

$G_{Fe}=G_{Fe2+}+2G_{e-}-(ΔG_{eq}+G_{H2O})=$ **140,609** kJ/mol; $G_{e-}=$**0,0** kJ/mol;

$G_{Fe(s)}=G_{Fe3+}-(ΔG_{eq\_Fe}+G_{H2O})=$**104,875**$-(-$**79,1364**$)=$**139,45** kJ/mol;

$G_{e-}=(G_{Fe}-(G_{Fe2+}+ΔG°))/2=($**140,609**$-($**12,04855-82,14**$))/2=$**105,35** kJ/mol;

[1] $ΔG_{Fe2+}=ΔH_H-T*ΔS_H=$-89,1-298,15*-0,1377=-48,045 kJ/mol;

$G_{e-}=(G_{Fe}-(G_{Fe2+}+ΔG°))/2=($**140,609**$-($**12,04855**-78,9$))/2=$**103,73** kJ/mol;

$G_{Fe2+}=G_{Fe3+}-(ΔG_{eq})=$**60,31655**$-($**48,268**$+0)=$**12,04855** kJ/mol;

$G_{Fe2+}=ΔG_{sp}-2G_{OH-}+(G_{Fe(OH)2}+3G_{H2O})=$**12,048** kJ/mol;

[37] $G_{Fe(OH)2}=ΔG°_{form}+(G_{Fe}+G_{O2}^{gas}+G_{H2}^{gas})=$**39,349** kJ/mol;

[8] Biochem.Thermodyn. Massachusetts Technology Inst. pH=7,36

$G_{e-}=(G_{Fe}-(G_{Fe3+}+ΔG°))/3=($**139,45**$-($**60,3136**$+($**-11,99**$)))/3=$**30,376** kJ/mol;

[1] $ΔG_{Fe3+}=ΔH_H-T*ΔS_H=$-48,5-298,15*-0,3159=45,685585 kJ/mol;

$G_{e-}=(G_{Fe}-(G_{Fe2+}+ΔG°))/3=($**139,45**$-($**60,3136**$+(-4,7)))/3=$**27,9455** kJ/mol;

$G_{Fe3+}=ΔG_{eq}-G_{e-}+(G_{Fe2+})=$**48,268-4,0405**$+($**12,048**$)=$**56,2755** kJ/mol;

$G_{Fe3+}=ΔG_{sp}-3G_{OH-}+(G_{Fe(OH)3}+4G_{H2O})=$**40,2605** kJ/mol;

$G_{[Fe(H2O)]3+}=G_{[Fe(OH)]2+}+G_{H3O+}-(ΔG_{prot}+G_{H2O})=$**60,31655** kJ/mol;

[1] $ΔG_{Fe3+}=ΔH_H-T*ΔS_H=$-324,7-298,15*0,029=-333,346 kJ/mol;

[1] $G_{e-}=ΔG°-G_{[Fe(OH)]+}+(G_{Fe}+G_{O2gas}/2+G_{H2}/2)=$**18,39245** kJ/mol;

[1] $G_{[Fe(OH)]+}=ΔG_{prot}-G_{H3O+}+(G_{[Fe(H2O)]2+}+G_{H2O})=$**38,02755** kJ/mol;

[1] $ΔG_{Fe3+}=ΔH_H-T*ΔS_H=$-229,4-298,15*0,142=-271,737 kJ/mol;

[1] $2G_{e-}=ΔG°-G_{[Fe(OH)]2+}+(G_{Fe}+G_{O2gas}/2+G_{H2}/2)=2*$**21,2773** kJ/mol;

[1] $G_{[Fe(OH)]2+}=ΔG_{prot}-G_{H3O+}+(G_{[Fe(H2O)]3+}+G_{H2O})=$**61,86545** kJ/mol;

[18] $G_{[Fe(OH)]2+}=ΔG_{stab\_eq}-G_{H2O}+(G_{[Fe(H2O)]3+}+G_{OH-})=$**60,3182** kJ/mol;

[18] $G_{[Fe(OH)]2+}=ΔG_{stab\_eq}-2G_{H2O}+(G_{[Fe(H2O)]3+}+2G_{OH-})=$**67,74** kJ/mol;

[38] $G_{[Fe(OH)]2+}=ΔG_p-2G_{H3O+}+(G_{[Fe(H2O)2]3+}+2G_{H2O})=$**47,8715** kJ/mol;

[1] $G_{e-}=ΔG°-G_{[Fe(OH)]2+}+(G_{Fe}+G_{O2gas}+G_{H2})=$**42,3185** kJ/mol;

[33] $ΔG_{Fe3+}=ΔH_H-T*ΔS_H=$-823-298,15*0,107=-854,902 kJ/mol;

$G_{Fe(OH)3}=ΔG°_{form}+(G_{Fe}+G_{O2}^{gas}+G_{H2}^{gas})=$**27,119** kJ/mol;

$G_{Fe(OH)3}=G_{Fe3+}+3G_{OH-}-(ΔG_{sp}+4G_{H2O})=$**12,4855** kJ/mol;

[33] $ΔG_H=ΔH_H-T*ΔS_H=$-740,6-298,15*0,092,88=-768,29 kJ/mol;

$G_{FeCO3}=ΔG°_{form}+(G_{Fe}+1{,}5G_{O2}^{gas}+G_{Cgraph})=$**19,819** kJ/mol;

$G_{FeCO3}=G_{Fe3+}+G_{CO32-}-(ΔG_{sp}+2G_{H2O})=$**83,01205** kJ/mol;

$ΔG_H=ΔH_H-T*ΔS_H=$-677,1-298,15*-0,0569=-660,135 kJ/mol;

$G_{e-}=(G_{CO32-}-(1{,}5G_{O2}^{gas}+G_{Cgraph}+ΔG°_{form}))/2=$**42,2212** kJ/mol;

$G_{CO32}=ΔG_{prot}-G_{H3O+}+(G_{HCO3-}+G_{H2O})=$**102,5523** kJ/mol;

$ΔG_H=ΔH_H-T*ΔS_H=$-692-298,15*0,0912=-719,19128 kJ/mol;

$G_{e-}=G_{HCO3-}-(1{,}5G_{O2}+G_{Cgr}+0{,}5G_{H2}+ΔG°_{form})=$**54,15** kJ/mol;

$G_{H3O+HCO3}=G_{H3O+}+G_{HCO3-}=$22,44+**56,08**=78,52 kJ/mol

$ΔG_{eq2}=$-99,8 kJ/mol$=2*G_{H2O}-(G_{H3O+}+G_{OH-})=2*$**0**$-($22,44+77,36$)$

$Fe_{(s)}+2H_2O=[Fe(OH)]^{2+}+H_3O^{+}+3e^{-}$; classic potential $E°_{classic}$=-0,037 V [1], water logarithm 0,0686634 and ΔE°:

$E°_{Fe/FeOH2+}=E°_{classic}-0{,}0591/3*\log(1/[H_2O]^2)+ΔE°=-0{,}037-0{,}0591/3*\log(1/55{,}3^{\wedge 2})+0{,}10166-0{,}37239=$ **-0,23907** V

$ΔG_{eq}=E°_{Fe/FeOH2+}•F•3=$**-0,2390666**$*96485*3=$**-69,199** kJ/mol,

$ΔG_{eq}=G_{FeOH2+}+G_{H3O+}+3G_{e-}-(G_{Fe(s)}+2G_{H2O})=$**61,866**$+$**22,44**$+3*$**-4,685**$-($**139,45**$+2*$**0**$)=$**-69,199** kJ/mol;

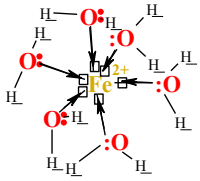
$3G_{e-}=ΔG_{eq}-G_{FeOH2+}-G_{H3O+}+(G_{Fe(s)}+2G_{H2O})=$**-69,199-61,866-22,44**$+($**139,45**$+2*$**0**$)=3*$**-4,685** kJ/mol;

$G_{Fe(s)}=G_{FeOH2+}+G_{H3O+}+3G_{e-}-(ΔG_{eq\_Fe}+2G_{H2O})=$**61,866**$+$**22,44**$+3*$**-4,685**$-($**-69,199**$+2*$**0**$)=$**139,45** kJ/mol;

$G_{FeOH2+}=ΔG_{eq}-G_{H3O+}-3G_{e-}+(G_{Fe(s)}+2G_{H2O})=$**-69,199-22,44**$-3*$**-4,685**$+($**139,45**$+2*$**0**$)=$**61,866** kJ/mol;

Iron(II/III) $Fe^{2+}=Fe^{3+}+e^-$; $E°_{Fe2+/Fe3+}$=**0,50027** V; potential has $E°_{classic}$=0,771 V water 0 zero and ΔE°: [1]

$E°_{Fe2+/Fe3+}=E°_{classic}-0,0591/1*\log(1/[H_2O]^0)+\Delta E°=0,771-0,0591/1*\log(1/55,3^{\wedge 0})+0,10166-0,37239=$**0,50027** V



$Fe^{2+}=Fe^{3+}+e^-$; $\Delta G_{eq}=E°_{Fe3+/Fe2+}•F•1=$**0,50027***96485*1=**48,268** kJ/mol;

$\Delta G_{eq}=G_{Fe3+}+G_{e-}-(G_{Fe2+})=$**56,2755+4,0405-(12,048)=48,268** kJ/mol;

$G_{e-}=G_{Fe3+}-\Delta G_{eq}+(G_{Fe2+})=$**56,2755-48,268+(12,048)=4,0405** kJ/mol;

$G_{Fe2+}=G_{Fe3+}+G_{e-}-(\Delta G_{eq})=$**56,2755+4,0405-(48,268)=12,048** kJ/mol;

$G_{Fe3+}=\Delta G_{eq}-G_{e-}+(G_{Fe2+})=$**48,268-4,0405+(12,048)=56,2755** kJ/mol;

Formation [1] $Fe^{3+}+3e^-=Fe$; $\Delta G°=G_{Fe}-(G_{Fe3+}+3G_{e-})=$**139,45-(60,3136**+3*$G_{e-}$)=-4,7 kJ/mol;

$G_{e-}=(G_{Fe}-(G_{Fe3+}+\Delta G°))/3=($**139,45-(60,3136**+(-4,7)))/3=**27,9455** kJ/mol;

Formation [8] $Fe^{3+}+3e^-=Fe$; $\Delta G°=G_{Fe}-(G_{Fe3+}+3G_{e-})=$**139,45-(60,3136**+3***30,376)=-11,99** kJ/mol;

$G_{e-}=(G_{Fe}-(G_{Fe3+}+\Delta G°))/3=($**139,45-(60,3136**+(**-11,99**)))/3=**30,376** kJ/mol;

Formation [8] $Fe^{2+}+2e^-=Fe$; $\Delta G°=G_{Fe}-(G_{Fe2+}+2G_{e-})=$**140,609-(12,04855**+2*$G_{e-}$)=**-82,14** kJ/mol;

$G_{e-}=(G_{Fe}-(G_{Fe2+}-\Delta G°))/2=($**140,609-(12,04855**+(**-82,14**)))/2=**105,35** kJ/mol;

Formation [1] $Fe^{2+}+2e^-=Fe$; $\Delta G°=G_{Fe}-(G_{Fe2+}+2G_{e-})=$**140,609-(12,04855**+2*$G_{e-}$)=-78,9 kJ/mol;

$G_{e-}=(G_{Fe}-(G_{Fe2+}-\Delta G°))/2=($**140,609-(12,04855**+(-78,9)))/2=**103,73** kJ/mol;

Formation $Fe+O_2^{gas}/2+H_2/2=[Fe(OH)]^+$+**e-**;

$\Delta G°=G_{[Fe(OH)]+}+G_{e-}-(G_{Fe}+G_{O2gas}/2+G_{H2}/2)=$**38,02755+18,39245-(139,45+303,1**/2+**85,64**/2)=-277,4 kJ/mol;

$G_{e-}=\Delta G°-G_{[Fe(OH)]+}+(G_{Fe}+G_{O2gas}/2+G_{H2}/2)=$-277,4-**38,02755**+(**139,45+303,1**/2+**85,64**/2)=**18,39245** kJ/mol;

Formation $Fe+O_2^{gas}/2+H_2/2=[Fe(OH)]^{2+}$+2**e-**;

$\Delta G°=G_{[Fe(OH)]2+}+2G_{e-}-(G_{Fe}+G_{O2gas}/2+G_{H2}/2)=$**61,86545**+2***21,277-(139,45+303,1**/2+**85,64**/2)=-229,4 kJ/mol;

$2G_{e-}=\Delta G°-G_{[Fe(OH)]+}+(G_{Fe}+G_{O2gas}/2+G_{H2}/2)=$-229,4-**61,86545**+(**139,45+303,1**/2+**85,64**/2)=2***21,277** kJ/mol;

Formation $Fe+O_2^{gas}+H_2=[Fe(OH)_2]^+$+**e-**;

$\Delta G°=G_{[Fe(OH)2]+}+2G_{e-}-(G_{Fe}+G_{O2gas}+G_{H2})=$**47,8715**+$G_{e-}$-(**139,45+303,1+85,64**)=-438 kJ/mol;

$G_{e-}=\Delta G°-G_{[Fe(OH)2]+}+(G_{Fe}+G_{O2gas}+G_{H2})=$-438-**47,8715**+(**139,45+303,1+85,64**)=**42,3185** kJ/mol;

[38] IUPAC Fe^{2+} Acid $[Fe(H_2O)]^{2+}+H_2O=[Fe(OH)]^++H_3O^+$; Prigogine attractor ΔG_{eq}=-RTln(K_{eq}),

Equilibrium constant $K_{prot\_eq}=[[Fe(OH)]^+]*[H_3O^+]^2/[[Fe(H_2O)]^{2+}]/[H_2O]=10^{\wedge(-6,74)}/55,3=10^{\wedge(-8,4827)}$;

Protolysis attractor ΔG_{prot_eq}=-RTln(K_{prot_eq})=-8,3144*298,15*ln($10^{\wedge(-8,4827)}$)=**48,419** kJ/mol;

Hess law expression $\Delta G_{prot}=G_{[Fe(OH)]+}+G_{H3O+}-(G_{[Fe(H2O)]2+}+G_{H2O})=$**38,02755+22,44-(12,04855+0)=48,419** kJ/mol;

$G_{[Fe(OH)]+}=\Delta G_{prot}-G_{H3O+}+(G_{[Fe(H2O)]2+}+G_{H2O})=$**48,419-22,44+(12,04855+0)=38,02755** kJ/mol;

[38] IUPAC Fe^{3+} Acid $[Fe(H_2O)]^{3+}+H_2O=Fe(OH)^{2+}+H_3O^+$; Prigogine attractor ΔG_{prot_eq}=-RTln(K_{prot_eq}).

Equilibrium constant $K_{prot\_eq}=[Fe(OH)^{2+}]*[H_3O^+]^2/[Fe(H_2O)^{3+}]/[H_2O]=10^{\wedge(-2,46)}/55,3=10^{\wedge(-4,2027)}$;

Protolysis attractor ΔG_{sp}=-RTln(K_{speq})=-8,3144*298,15*ln($10^{\wedge(-4,2027)}$)=**23,9889** kJ/mol;

Hess law expression $\Delta G_{prot}=G_{[Fe(OH)]2+}+G_{H3O+}-(G_{[Fe(H2O)]3+}+G_{H2O})=$**61,86545+22,44-(60,31655+0)=23,9889** kJ/mol;

$G_{[Fe(OH)]2+}=\Delta G_{prot}-G_{H3O+}+(G_{[Fe(H2O)]3+}+G_{H2O})=$**23,9889-22,44+(60,31655+0)=61,86545** kJ/mol;

$G_{[Fe(H2O)]3+}=G_{[Fe(OH)]2+}+G_{H3O+}-(\Delta G_{prot}+G_{H2O})=$**61,86545+22,44-(23,9889+0)=60,31655** kJ/mol;

[38] IUPAC Fe^{3+} Acid $Fe(H_2O)^{3+}+H_2O=Fe(OH)^{2+}+H_3O^+$;

$K_{prot\_eq}=[Fe(OH)^{2+}]*[H_3O^+]^2/[Fe(H_2O)^{3+}]/[H_2O]=10^{\wedge(-2,46)}/55,3=10^{\wedge(-4,2027)}$;

Protolysis attractor ΔG_{prot_eq}=-RTln(K_{prot_eq})=-8,3144*298,15*ln($10^{\wedge(-4,2027)}$)=**23,9889** kJ/mol;

$\Delta G_{prot\_eq}=G_{[Fe(OH)]2+}+G_{H3O+}-(G_{[Fe(H2O)]3+}+G_{H2O})=$**61,86545+22,44-(60,31655+0)=23,9889** kJ/mol;

$G_{[Fe(OH)]2+}=\Delta G_{prot}-G_{H3O+}+(G_{[Fe(H2O)]3+}+G_{H2O})=$**23,9889-22,44+(60,31655+0)=61,86545** kJ/mol;

$G_{[Fe(H2O)]3+}=G_{[Fe(OH)]2+}+G_{H3O+}-(\Delta G_{prot}+G_{H2O})=$**61,86545+22,44-(23,9889+0)=60,31655** kJ/mol;

[18] $Fe(H_2O)^{3+}+OH^-=Fe(OH)^{2+}+H_2O$;

$K_{stab\_eq}=ß_1*[H_2O]=[Fe(OH)^{2+}]*[H_2O]/[Fe^{3+}]/[OH^-]=10^{\wedge 11,81}*55,3=10^{\wedge 13,5527}$;

Stability attractor ΔG_{stab_eq}=-RTln(K_{stab_eq})=-8,3144*298,15*ln($10^{\wedge 13,5527}$)=**-77,35836** kJ/mol;

$\Delta G_{stab\_eq}=G_{[Fe(OH)]2+}+G_{H2O}-(G_{[Fe(H2O)]3+}+G_{OH-})=$**60,31819+0-(60,31655+77,36)=-77,35836** kJ/mol;

$G_{[Fe(OH)]2+}=\Delta G_{stab\_eq}-G_{H2O}+(G_{[Fe(H2O)]3+}+G_{OH-})=$**-77,35836-0+(60,31655+77,36)=60,31819** kJ/mol;

[18] $[Fe(H_2O)_2]^{3+}+2OH^-=Fe(OH)_2{}^{+}+2H_2O$;

$K_{stab\_eq}=ß_2*[H_2O]^2=[Fe(OH)_2{}^{+}]*[H_2O]^2/[Fe^{3+}]/[OH^-]^2=10^{\wedge 22,32}*55,3^{\wedge 2}=10^{\wedge 25,80545}$;

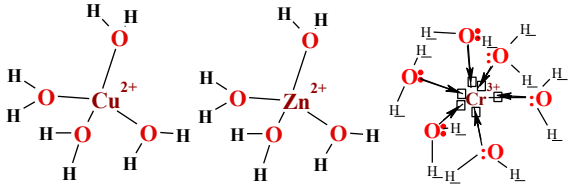
Stability attractor ΔG_{stab_eq}=-RTln(K_{stab_eq})=-8,3144*298,15*ln($10^{\wedge 25,80545}$)=**-147,2966** kJ/mol;

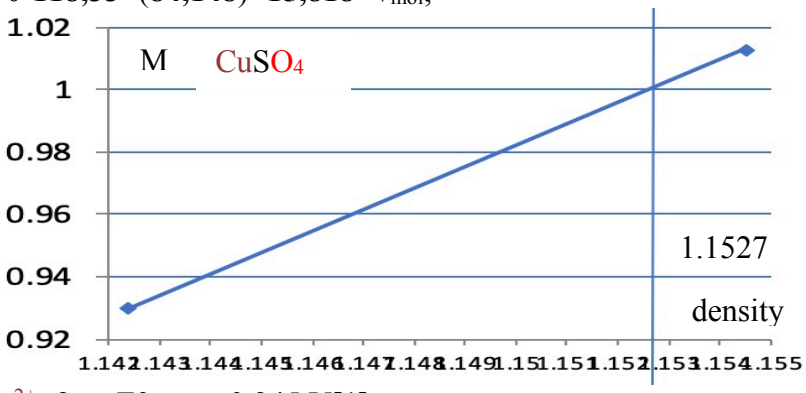
$\Delta G_{stab\_eq}=G_{[Fe(OH)]2+}+2G_{H2O}-(G_{[Fe(H2O)]3+}+2G_{OH-})=$**67,73995**+2***0-(60,31655**+2***77,36)=-147,2966** kJ/mol;

$G_{[Fe(OH)]2+}=\Delta G_{stab\_eq}-2G_{H2O}+(G_{[Fe(H2O)]3+}+2G_{OH-})=$**-147,2966**-2***0+(60,31655**+2***77,36)=67,73995** kJ/mol;

Formation [1] $Cu^{2+}+2e^{-}=Cu$; $\Delta G°=G_{Cu2+}+2G_{e-}-(G_{Cu})=$**108,618**$+2*G_{e-}-($**84,148**$)=65,5$ $^{kJ}/_{mol}$;
Formation [1] $Cu^{2+}+2e^{-}=Cu$; $G_{e-}=(\Delta G°-G_{Cu2+}+(G_{Cu}))/2=(65,5-$**108,618**$+($**84,148**$))/2=$**20,515** $^{kJ}/_{mol}$;
Formation [1] $Cu=Cu^{+}+e^{-}$; $\Delta G°=G_{Cu+}+G_{e-}-(G_{Cu})=$**118,33**$+G_{e-}-($**84,148**$)=50$ $^{kJ}/_{mol}$;
Formation [1] $Cu=Cu^{+}+e^{-}$; $G_{e-}=\Delta G°-G_{Cu+}+(G_{Cu})=50-$**118,33**$+($**84,148**$)=$**15,818** $^{kJ}/_{mol}$;

$[Cu^{2+}]$=1 M mol M_{CuSO4}=159,602 $^{g}/_{mol}$ mas, density 1,1527 $^{g}/_{mL}$; [1] Absolute potential has classic $E°_{Classic}$=0,345 V [1], water logarithm 0,051497, sum $\Delta E°$=+0,10166-0,37239:





$Cu(Hg)+H_2O=Cu^{2+}+2e^{-}$; $E°_{Classic}$=0,345 V[1].
$E°_{Cu/Cu2+}=E°_{Classic}$-0,0591/2*log(1/[$H_2O$])$+\Delta E°_{Cu}$=0,345-0,0591/2*log(1/55,3)+0,10166-0,371339=**0,12682** V.
$\Delta G_{eq\_Cu}=E°_{Cu}•F•2=$**0,1268185**$*96485*2=$**24,472** $^{kJ}/_{mol}$,
$\Delta G_{eq\_Cu}=G_{Cu2+}+2G_{e-}-(G_{Cu}+G_{H2O})=$**108,618**$+2*0-($**84,148**$+0)=$**24,47** $^{kJ}/_{mol}$;
$G_{Cu}=G_{Cu2+}+2G_{e-}-(\Delta G_{eq\_Cu}+G_{H2O})=$**108,618**$+2*0-($**24,47**$+0)=$**84,148** $^{kJ}/_{mol}$;
$2G_{e-}=\Delta G_{eq\_Cu}-G_{Cu2+}+(G_{Cu}+G_{H2O})=$ **24,47-108,618**$+($**84,148**$+0)=$ **2*0** $^{kJ}/_{mol}$;
$E_{Cu}=E°_{Cu}+0,0591/2*\log([Cu^{2+}]/[Cu]/([H_2O]))=$**0,12682**$+0,0591/2*\log(1/1/(55,3))=0,075322$ V;
$E_{Cu}=E°_{Cu}+0,0591/2*\log([Cu^{2+}]/[Cu]/([H_2O]-4[Cu^{2+}]))=$**0,12682**$+0,0591/2*\log(1/1/(57,24-4))=0,07581$ V;
$m_{H2O}=(m_L-m_{CuSO4})/18=1190-159,602=1030,4/18=57,24-4=53,24$ mol;
Distinguish from 0,075322 V is on 3rd digit 0,07581 V.

Viela	$\Delta H°_H$ $^{kJ}/_{mol}$	$\Delta S°_H$ $^{J}/_{mol/K}$	$\Delta G°_H$, $^{kJ}/_{mol}$
Cu	$E°_{Cu2+}$=	0,**12682** V	**84,148**
Cu_2O	-168,6	93,1	-146,0
Cu_2O	formation	-146,0	**173,846**
CuO	-157,3	42,6	-129,7
CuO	formation	-129,7	**105,998**
Cu^{+}	71,7	40,6	50,0
Cu^{+}	$E°_{Cu}$=	**0,35432**V	**118,33**
G_{e-} Cu^{+}	formation	50	**15,818**
Cu^{2+}	64,8	-99,6	65,5
Cu^{2+}	K_{sp}=	$10^{-24,886}$	**108,618**
G_{e-} Cu^{2+}	formation	65,5	**20,515**
$Cu(OH)_2$	-449,8	108	-337
$Cu(OH)_2$	Formation	-337	**121,29**
$Cu(OH)_2$	K_{sp}=	$10^{-24,886}$	**121,29**
CO_3^{2-}	-677,1	-56,9	-527,8
$CuCO_3$	Formation	-527,8	**102,258**
CO_3^{2-}	K_{sp}=	$10^{-13,339}$	**70,07286**
$C_2O_4^{2-}$	-825,1	45,6	-673,9
$C_2O_4^{2-}$	formation	-673,9	**114,62**
$C_2O_4^{2-}$	K_{sp}=	$10^{-12,839}$	**40,1746**
CuC_2O_4	formation	-797,16	**75,508**
S^{2-}	33,1	-14,6	85,8
S^{2-}	$E°_{S↓/S2-}$=	**-0,79853**V	**157,63**
S^{2-}	K_{sp}=	$10^{-39,7073}$	**152,1216**
CuS	-53,1	66,5	-53,6
CuS	formation	-53,6	**34,0916**

[1]$\Delta H°_{Cu(OH)2}$=-449,8 $^{kJ}/_{mol}$; $G_{Srhombic}$=**3,5436** $^{kJ}/_{mol}$;
$G_{Cu}=G_{Cu2+}-(\Delta G_{eq\_Cu}+G_{H2O})=$**108,618**$-($**24,47**$+0)=$**84,148** $^{kJ}/_{mol}$;
[1] $\Delta G_{CuO}=\Delta H_H-T*\Delta S_H=-168,6-298,15*0,0931=-196,358$ $^{kJ}/_{mol}$;
[1] $G_{CuO}=\Delta G°_{CuO}+(2G_{Cu}+G_{O2}/2)=-146,0=$**173,846** $^{kJ}/_{mol}$;
[1] $\Delta G_{CuO}=\Delta H_H-T*\Delta S_H=-157,3-298,15*0,0426=-170$ $^{kJ}/_{mol}$;
[1] $G_{CuO}=\Delta G°_{CuO}+(G_{Cu}+G_{O2}/2)=-129,7=$**105,998** $^{kJ}/_{mol}$;
[1] $\Delta G_{Cu2+}=\Delta H_H-T*\Delta S_H=71,7-298,15*0,0406=59,595$ $^{kJ}/_{mol}$;
$G_{Cu+}=\Delta G_{eq\_Cu}+(G_{Cu}+G_{H2O})=$**34,1866+84,148=118,33** $^{kJ}/_{mol}$;
[1] Formation $Cu=Cu^{+}+e^{-}$; $G_{e-}=\Delta G°-G_{Cu+}+(G_{Cu})=$ **15,818** $^{kJ}/_{mol}$;
[1] $\Delta G_{Cu2+}=\Delta H_H-T*\Delta S_H=64,8-298,15*-0,098=94,0187$ $^{kJ}/_{mol}$;
$G_{Cu2+}=\Delta G_{sp}-2G_{OH-}+(G_{Cu(OH)2}+3G_{H2O})=$**108,618** $^{kJ}/_{mol}$;
$G_{e-}=(\Delta G°-G_{Cu2+}+(G_{Cu}))/2=(65,5-$**108,618**$+($**84,148**$))/2=$**20,515** $^{kJ}/_{mol}$;
[33]$\Delta G_{Cu(OH)2}=\Delta H_H-T*\Delta S_H=-450,2-298,15*-0,108=-418$ $^{kJ}/_{mol}$;
$G_{Cu(OH)2}=\Delta G°_{form}+(G_{Cu}+G_{O2}{}^{gas}+G_{H2}{}^{gas})=$**121,29** $^{kJ}/_{mol}$;
$G_{Cu(OH)2}=G_{Cu2+}+2G_{OH-}-(\Delta G_{sp}+3G_{H2O})=$**121,29** $^{kJ}/_{mol}$;
$\Delta G_H=\Delta H_H-T*\Delta S_H=-677,1-298,15*-0,0569=-660,135$ $^{kJ}/_{mol}$;
$G_{CuCO3}=\Delta G°_{form}+(G_{Cu}+1,5G_{O2}{}^{gas}+G_{Cgraph})=$**102,258** $^{kJ}/_{mol}$;
$G_{CO32-}=\Delta G_{sp}-G_{Cu2+}+(G_{CuCO3}+2G_{H2O})=$**70,07286** $^{kJ}/_{mol}$;
[1] $\Delta G_H=\Delta H_H-T*\Delta S_H=-825,1-298,15*0,0456=-862,637$ $^{kJ}/_{mol}$;
$G_{C2O4(2-)}=\Delta G°_{C2O4(2-)Form}+(2G_{Cgr}+2G_{O2}{}^{gas}+2G_{e-})=$**114,62** $^{kJ}/_{mol}$;
$G_{C2O42-}=\Delta G_{sp}-G_{Cu2+}+(G_{CuC2O4}+2G_{H2O})=$**40,1746** $^{kJ}/_{mol}$;
$G_{CuC2O4cr}=\Delta G°_{CuC2O4crForm}+(Cu+2O_2{}^{gas}+2C_{graph})=$**75,508** $^{kJ}/_{mol}$;
[1] $\Delta G_H=\Delta H_H-T*\Delta S_H=33,1-298,15*-0,0146=-862,637$ $^{kJ}/_{mol}$;
$G_{S2-aq}=G_{Srombic}+G_{H2O}-(\Delta G_{eqS2-aq})=$**157,63** $^{kJ}/_{mol}$;
$G_{S2-}=\Delta G_{sp}-G_{Cu2+}+(G_{CuS}+2G_{H2O})=$**152,1216** $^{kJ}/_{mol}$;
[1] $\Delta G_H=\Delta H_H-T*\Delta S_H=-53,164,8-298,15*0,0665=-72,99$ $^{kJ}/_{mol}$;
$G_{CuS}=\Delta G°_{form}+(G_{Cu}+G_{Sromb})=$**34,0916** $^{kJ}/_{mol}$;

Formation [1] $2Cu+O=Cu_2O$; $\Delta G°_{Cu2O}=G_{Cu2O}-(2G_{Cu}+G_{O2}/2)=G_{CuO}-(2*$**84,148**$+$**303,1**$/2)=-146,0$ $^{kJ}/_{mol}$;
$G_{CuO}=\Delta G°_{CuO}+(2G_{Cu}+G_{O2}/2)=-146,0+(2*$**84,148**$+$**303,1**$/2)=$**173,846** $^{kJ}/_{mol}$;

Formation [1] $Cu+O=CuO$; $\Delta G°_{CuO}=G_{CuO}-(G_{Cu}+G_{O2}/2)=G_{CuO}-(\mathbf{84,148}+\mathbf{303,1}/2)=-129,7$ $^{kJ}/_{mol}$;

$G_{CuO}=\Delta G°_{CuO}+(G_{Cu}+G_{O2}/2)=-129,7+(\mathbf{84,148}+\mathbf{303,1}/2)=\mathbf{105,998}$ $^{kJ}/_{mol}$;

$Cu+H_2O=Cu^{+}+\mathbf{2e^{-}}$; $E°_{Classic}=0,521$ V[1].

$E°_{Cu/Cu+}=E°_{Classic}-0,0591*\log(1/[H_2O])+\Delta E°_{Cu}=0,521-0,0591*\log(1/55,3)+0,10166-0,371339=\mathbf{0,35432}$ V.

$\Delta\mathbf{G}_{\mathbf{eq}\_Cu}=E°_{Cu}\bullet F\bullet 1=\mathbf{0,35432}*96485*1=\mathbf{34,1866}$ $^{kJ}/_{mol}$,

$\Delta\mathbf{G}_{\mathbf{eq}\_Cu}=G_{Cu+}+G_{e-}-(G_{Cu}+G_{H2O})=\mathbf{118,33}+\mathbf{0,00460}-(\mathbf{84,148}+\mathbf{0})=\mathbf{34,1866}$ $^{kJ}/_{mol}$;

$G_{Cu+}=\Delta\mathbf{G}_{\mathbf{eq}Cu}-G_{e-}+(G_{Cu}+G_{H2O})=\mathbf{34,1866}-\mathbf{0,00460}+(\mathbf{84,148}+\mathbf{0})=\mathbf{118,33}$ $^{kJ}/_{mol}$;

$G_{e-}=\Delta\mathbf{G}_{\mathbf{eq}Cu}-G_{Cu+}+(G_{Cu}+G_{H2O})=\mathbf{34,1866}-\mathbf{118,33}+(\mathbf{84,148}+\mathbf{0})=\mathbf{0,00460}$ $^{kJ}/_{mol}$;

$G_{Cu}=G_{Cu+}+G_{e-}-(\Delta\mathbf{G}_{\mathbf{eq}\_Cu}+G_{H2O})=\mathbf{118,33}+\mathbf{0,00460}-(\mathbf{34,1866}+\mathbf{0})=\mathbf{84,148}$ $^{kJ}/_{mol}$;

Formation $Cu+O_{2g}+H_{2g}=Cu(OH)_2$; $\Delta G°=G_{Cu(OH)2}-(G_{Cu}+G_{O2g}+G_{H2g})=\mathbf{121,29}-(\mathbf{69,5467}+\mathbf{303,1}+\mathbf{85,64})=-337$ $^{kJ}/_{mol}$;

$G_{Cu(OH)2}=\Delta G°_{form}+(G_{Cu}+G_{O2}^{gas}+G_{H2}^{gas})=-337+(\mathbf{69,5467}+\mathbf{303,1}+\mathbf{85,64})=\mathbf{121,29}$ $^{kJ}/_{mol}$;

[33] Solubility $Cu(OH)_2+3H_2O=Cu^{2+}+2OH^{-}$; $K_{sp}=[Cu^{2+}]*[OH^{-}]^2/[H_2O]^3=2,2*10^{\wedge(-20)}/55,3^{\wedge 3}=10^{\wedge(-24,886)}$;

Attractor $\Delta\mathbf{G}_{sp}=-RT\ln(\mathbf{K}_{speq})=-8,3144*298,15*\ln(10^{\wedge(-24,886)})=\mathbf{142,048}$ $^{kJ}/_{mol}$

$\Delta G_{sp}=G_{Cu2+}+2G_{OH-}-(G_{Cu(OH)2}+3G_{H2O})=G_{Cu2+}+2*\mathbf{77,36}-(\mathbf{121,29}+3*\mathbf{0})=\mathbf{142,048}$ $^{kJ}/_{mol}$;

$G_{Cu2+}=\Delta G_{sp}-2G_{OH-}+(G_{Cu(OH)2}+3G_{H2O})=\mathbf{142,048}-2*\mathbf{77,36}+(\mathbf{121,29}+3*\mathbf{0})=\mathbf{108,618}$ $^{kJ}/_{mol}$;

$G_{Cu(OH)2}=G_{Cu2+}+2G_{OH-}-(\Delta G_{sp}+3G_{H2O})=\mathbf{108,618}+2*\mathbf{77,36}-(\mathbf{142,048}+3*\mathbf{0})=\mathbf{121,29}$ $^{kJ}/_{mol}$;

Formation $Cu+1,5O_2^{gas}+C_{graph}=CuCO_3$; $Cu+S_{romb}=CuS$; Formation $Cu+2O_2^{gas}+2C_{graph}=CuC_2O_4$;

$\Delta G°_{form}=G_{CuCO3}-(G_{Cu}+1,5G_{O2}^{gas}+G_{Cgraph})=\mathbf{102,258}-(\mathbf{84,148}+1,5*\mathbf{303,1}+\mathbf{91,26})=-527,8$ $^{kJ}/_{mol}$; [1]

$G_{CuCO3}=\Delta G°_{form}+(G_{Cu}+1,5G_{O2}^{gas}+G_{Cgraph})=-527,8+(\mathbf{84,148}+1,5*\mathbf{303,1}+\mathbf{91,26})=\mathbf{102,258}$ $^{kJ}/_{mol}$;

$\Delta G°_{form}=G_{CuS}-(G_{Cu}+G_{Sromb})=\mathbf{34,0916}-(\mathbf{84,148}+\mathbf{3,5436})=-53,6$ $^{kJ}/_{mol}$;

$G_{CuS}=\Delta G°_{form}+(G_{Cu}+G_{Sromb})=-53,6+(\mathbf{84,148}+\mathbf{3,5436})=\mathbf{34,0916}$ $^{kJ}/_{mol}$;

$\Delta G°_{CuC2O4crForm}=G_{CuC2O4cr}-(Cu+2O_2^{gas}+\mathbf{2}C_{graph})=\mathbf{75,508}-(\mathbf{84,148}+2*\mathbf{303}+2*\mathbf{91,26})=-797,16$ $^{kJ}/_{mol}$.

$G_{CuC2O4cr}=\Delta G°_{CuC2O4crForm}+(Cu+2O_2^{gas}+\mathbf{2}C_{graph})=-797,16+(\mathbf{84,148}+2*\mathbf{303}+2*\mathbf{91,26})=\mathbf{75,508}$ $^{kJ}/_{mol}$.

[33] Solubility $CuCO_3+2H_2O=Cu^{2+}+CO_3^{2-}$; $K_{sp}=[Cu^{2+}]*[CO_3^{2-}]/[H_2O]^2=1,4*10^{\wedge(-10)}/55,3^{\wedge 2}=10^{\wedge(-13,339)}$;

Attractor $\Delta\mathbf{G}_{sp}=-RT\ln(\mathbf{K}_{speq})=-8,3144*298,15*\ln(10^{\wedge(-13,339)})=\mathbf{76,13856}$ $^{kJ}/_{mol}$

$\Delta G_{sp}=G_{Cu2+}+G_{CO32-}-(G_{CuCO3}+2G_{H2O})=\mathbf{108,618}+\mathbf{70,07286}-(\mathbf{102,5523}+2*\mathbf{0})=\mathbf{76,13856}$ $^{kJ}/_{mol}$;

$G_{CO32-}=\Delta G_{sp}-G_{Cu2+}+(G_{CuCO3}+2G_{H2O})=\mathbf{76,13856}-\mathbf{108,618}+(\mathbf{102,5523}+2*\mathbf{0})=\mathbf{70,07286}$ $^{kJ}/_{mol}$;

[1] Solubility $CuC_2O_4+2H_2O=Cu^{2+}+C_2O_4^{2-}$; $K_{sp}=[Cu^{2+}]*[C_2O_4^{2-}]/[H_2O]^2=4,43*10^{\wedge(-10)}/55,3^{\wedge 2}=10^{\wedge(-12,839)}$;

Attractor $\Delta\mathbf{G}_{sp}=-RT\ln(\mathbf{K}_{speq})=-8,3144*298,15*\ln(10^{\wedge(-12,839)})=\mathbf{73,2846}$ $^{kJ}/_{mol}$

$\Delta G_{sp}=G_{Cu2+}+G_{C2O42-}-(G_{CuC2O4}+2G_{H2O})=\mathbf{108,618}+\mathbf{40,1746}-(\mathbf{102,5523}+2*\mathbf{0})=\mathbf{73,2846}$ $^{kJ}/_{mol}$;

$G_{C2O42-}=\Delta G_{sp}-G_{Cu2+}+(G_{CuC2O4}+2G_{H2O})=\mathbf{73,2846}-\mathbf{108,618}+(\mathbf{75,508}+2*\mathbf{0})=\mathbf{40,1746}$ $^{kJ}/_{mol}$;

[33] Solubility $CuS+2H_2O=Cu^{2+}+S^{2-}$; $K_{sp}=[Cu^{2+}]*[S^{2-}]/[H_2O]^2=6*10^{\wedge(-37)}/55,3^{\wedge 2}=10^{\wedge(-24,886)}$;

Attractor $\Delta\mathbf{G}_{sp}=-RT\ln(\mathbf{K}_{speq})=-8,3144*298,15*\ln(10^{\wedge(-39,707299)})=\mathbf{226,648}$ $^{kJ}/_{mol}$

$\Delta G_{sp}=G_{Cu2+}+G_{S2-}-(G_{CuS}+2G_{H2O})=\mathbf{108,618}+\mathbf{152,1216}-(\mathbf{34,0916}+2*\mathbf{0})=\mathbf{226,648}$ $^{kJ}/_{mol}$;

$G_{S2-}=\Delta G_{sp}-G_{Cu2+}+(G_{CuS}+2G_{H2O})=\mathbf{226,648}-\mathbf{108,618}+(\mathbf{34,0916}+2*\mathbf{0})=\mathbf{152,1216}$ $^{kJ}/_{mol}$;

Prigogine absolute energy attractors for dissolution, protolysis, and reduction-oxidation of zink compounds.

Formation [1] $2C_{gr}+3O_2^{gas}+Zn+2\mathbf{H}_2^{gas}=ZnC_2O_4\bullet 2H_2O$ -solubility $ZnC_2O_{4(s)}+2H_2O=Zn^{2+}+C_2O_4^{2-}$ $K_{sp}=0{,}0026^{\wedge 2}$;
$\Delta G°=G_{ZnC2O4\bullet 2H2O}-(G_{Zn}+3G_{O2g}+2G_{graph}+2G_{H2})=\mathbf{321{,}7642}-(\mathbf{404{,}657}+3*\mathbf{303{,}1}+2*\mathbf{91{,}26}+2*\mathbf{85{,}64})=-1345{,}99$ $^{kJ}/_{mol}$;
$G_{ZnC2O4\bullet 2H2O}=\Delta G°+(G_{Zn}+3G_{O2g}+2G_{graph}+2G_{H2})=-1345{,}9928+(\mathbf{404{,}66}+3*\mathbf{303{,}1}+2*\mathbf{91{,}26}+2*\mathbf{85{,}64})=\mathbf{321{,}76}$ $^{kJ}/_{mol}$;
[1] Solubility $ZnC_2O_4+2H_2O=Zn^{2+}+C_2O_4^{2-}$; $M_{ZnC2O4}=0{,}00026/153{,}4=10^{\wedge(-5{,}77085)}$ M;
$K_{eqsp}=[Zn^{2+}]*[C_2O_4^{2-}]/[H_2O]^2=10^{\wedge(-5{,}77085*2)}/55{,}3^{\wedge 2}=10^{\wedge(-15{,}027)}$;
Attractor $\Delta\mathbf{G}_{sp}=-RT\ln(\mathbf{K}_{sp})=-8{,}3144*298{,}15*\ln(10^{\wedge(-15{,}027)})=\mathbf{85{,}7736}$ $^{kJ}/_{mol}$;
$\Delta G_{sp}=G_{Zn2+}+G_{C2O42-}-(G_{ZnC2O4}+2G_{H2O})=\mathbf{404{,}657}+\mathbf{207{,}188}-(\mathbf{526{,}0714}+2*\mathbf{0})=\mathbf{85{,}7736}$ $^{kJ}/_{mol}$;
$G_{ZnC2O4}=G_{Zn2+}+G_{CO32-}-(\Delta G_{sp}+2G_{H2O})=\mathbf{404{,}657}+\mathbf{207{,}188}-(\mathbf{85{,}7736}+2*\mathbf{0})=\mathbf{526{,}0714}$ $^{kJ}/_{mol}$;
$G_{C2O42-}=\Delta G_{sp}-G_{Zn2+}+(G_{ZnC2O4}+2G_{H2O})=\mathbf{85{,}7736}-\mathbf{404{,}657}+(\mathbf{526{,}0714}+2*\mathbf{0})=\mathbf{207{,}188}$ $^{kJ}/_{mol}$;

Substance	$\Delta H°_H$ $^{kJ}/_{mol}$	$\Delta S°_H$ $^{J}/_{mol/K}$	$\Delta G°_H$, $^{kJ}/_{mol}$
Zn	$E°_{Zn}=$	**-0,980** V	**404,657**
Zn	Formation	-147,1	**404,657**
Zn^{2+}	-153,9	-112,1	-147,1
Zn^{2+}	formation	-147,1	**215,55**
G_{e-} Zn^{2+}	Free e-	-147,1	**14,415**
$Zn(OH)^+$	format G_{e-}	-330,1	**13,642**
$Zn(OH)^+$	$K_{aeqZn(2+}$	$=10^{-10{,}8927}$	**255,285**
$Zn(OH)^+$	K_{stab_eq}	$=10^{3{,}297275}$	**274,089**
$Zn(H_2O)^{2+}$	format-$2G_{e-}$	**14,415**	**215,55**
$G_{e-}Zn^{2+}$	$E°_{Zn}=$	**-0,980** V	**0,0**
Zn^{2+}	$E°_{Zn}=$	**-0,980** V	**215,55**
Zn^{2+}	$K_{spZn(OH)2}=$	$10^{\wedge -25{,}149}$	**228,727**
$Zn(OH)_2$	-641,9	81,2	-553,5
$Zn(OH)_2$	formation	-553,5	**239,897**
$Zn(OH)_2$	$K_{spZn(OH)2}=$	$10^{\wedge -25{,}149}$	**239,897**
$ZnCO_3$	-812,8	82,4	-731,3
$ZnCO_3$	formation	-731,3	**219,267**
CO_3^{2-}	-677,1	-56,9	-527,8
CO_3^{2-}	formation	-527,8	**46,94**
ZnS	-206,0	57,7	-201,3
ZnS	formation	-201,3	**206,90**
S^{2-}	33,1	-14,6	85,8
S^{2-}	formation	if**14,415**	**118,1736**
G_{e-} S^{2-}	Free e-	85,8 if	**34,1432**
S^{2-}	$E°_{S\downarrow/S2-}=$	**-0.79853**V	**157.63**
$ZnC_2O_4\bullet 2H_2O$	-1564,816	195,3928	-1345.9928
$ZnC_2O_4\bullet 2H_2O$	formation	-1345.99	**321,76**
ZnC_2O_4	$K_{sp}=$	$10^{-8{,}6555}$	**526,0714**
$C_2O_4^{2-}$	formation	-pH=7,36	**-677,14**
$C_2O_4^{2-}$	-825,1	45,6	-673,9
$C_2O_4^{2-}$	formation	-673,9	**114,62**
$C_2O_4^{2-}$	formation	**-677,14**	**111,38**
$C_2O_4^{2-}$	$_{ZnC2O4}K_{sp}=$	$10^{-15{,}027}$	**207,188**
$C_2O_4^{2-}$	$_{acid\_2}$ **33,563**	pK_{a2}=5,88	**207,173**
$C_2O_4^{2-}$	$E°_{C2O4}=$	**-0,7607** V	**183,55**

$G_{O2}^{gas}=\mathbf{303{,}1}$ $^{kJ}/_{mol}$; $G_{H2}^{gas}=\mathbf{85{,}64}$ $^{kJ}/_{mol}$; $G_{Cgraph}=\mathbf{91{,}26}$ $^{kJ}/_{mol}$;
$G_{Zn}=G_{Zn2+}-(\Delta\mathbf{G}_{eq\_Zn}+\mathbf{G_{H2O}})=\mathbf{215{,}55}-(-\mathbf{189{,}107}+0)=\mathbf{404{,}657}$ $^{kJ}/_{mol}$;
$G_{Zn}=G_{Zn(OH)2}-(\Delta G°+G_{O2g}+G_{H2g})=\mathbf{404{,}657}$ $^{kJ}/_{mol}$;
[1] $\Delta G_{Zn2+}=\Delta H_H-T*\Delta S_H=-153{,}39-298{,}15*-0{,}112=-119{,}967$ $^{kJ}/_{mol}$;
$G_{Zn2+}=G_{Zn}-(\Delta G°+2G_{e-})=\mathbf{391{,}48}-(-147{,}1+2*\mathbf{161{,}515})=\mathbf{215{,}55}$ $^{kJ}/_{mol}$;
$G_{e-}=\Delta G°-G_{Zn2+}+(G_{Zn})=(-147{,}1-\mathbf{215{,}55}+(\mathbf{391{,}48}))/2=\mathbf{14{,}415}$ $^{kJ}/_{mol}$;
$G_{e-}=\Delta G°-G_{[Zn(OH)]+}+(G_{Zn}+G_{O2gas}/2+G_{H2}/2)=-330{,}1=\mathbf{13{,}642}$ $^{kJ}/_{mol}$;
$G_{[Zn(OH)]+}=\Delta G_{prot}-G_{H3O+}+(G_{[Zn(H2O)]2+}+G_{H2O})=\mathbf{255{,}285}$ $^{kJ}/_{mol}$;
$G_{[Zn(OH)]+}=\Delta G_{stab\_eq}-G_{H2O}-(G_{[Zn(H2O)]2+}+G_{OH-})=\mathbf{274{,}089}$ $^{kJ}/_{mol}$;
$G_{Zn2+}=\Delta G°-2G_{e-}+(G_{Zn})=-147{,}1-2*\mathbf{14{,}415}+(\mathbf{391{,}48})=\mathbf{215{,}55}$ $^{kJ}/_{mol}$;
$2G_{e-}=\Delta\mathbf{G}_{eqZn}-G_{Zn2+}+(G_{Zn}+G_{H2O})=\mathbf{0{,}0}$ $^{kJ}/_{mol}$;
$G_{Zn2+}=\Delta\mathbf{G}_{eq\_Zn}+(G_{Zn}+\mathbf{G_{H2O}})=-\mathbf{189{,}107}+(\mathbf{404{,}657}+0)=\mathbf{215{,}55}$ $^{kJ}/_{mol}$;
$G_{Zn2+}=\Delta G_{sp}-2G_{OH-}+(G_{Zn(OH)2}+3G_{H2O})=\mathbf{215{,}55}$ $^{kJ}/_{mol}$;
[1] $\Delta G_{Zn2+}=\Delta H_H-T*\Delta S_H=-641{,}9-298{,}15*0{,}0812=-666{,}11$ $^{kJ}/_{mol}$;
$G_{Zn(OH)2}=\Delta G°_{form}+(G_{Zn}+G_{O2}^{gas}+G_{H2}^{gas})=\mathbf{239{,}897}$ $^{kJ}/_{mol}$;
$G_{Zn(OH)2}=G_{Zn2+}+2G_{OH-}-(\Delta G_{sp}+3G_{H2O})=\mathbf{239{,}897}$ $^{kJ}/_{mol}$;
[1] $\Delta G_{Zn2+}=\Delta H_H-T*\Delta S_H=-812{,}8-298{,}15*0{,}824=-1058{,}48$ $^{kJ}/_{mol}$;
$G_{ZnCO3}=\Delta G°_{form}+(G_{Zn}+1{,}5G_{O2}^{gas}+G_{H2}^{gas})=\mathbf{219{,}267}$ $^{kJ}/_{mol}$;
[1]$\Delta G_H=\Delta H_H-T*\Delta S_H=-677{,}1-298{,}15*-0{,}0569=-660{,}135$ $^{kJ}/_{mol}$;
$G_{CO32-}=\Delta G°+(1{,}5G_{O2g}+G_{graph}+2G_{e-})=\mathbf{46{,}94}$ $^{kJ}/_{mol}$;
[1] $\Delta G_{Zn2+}=\Delta H_H-T*\Delta S_H=-206-298{,}15*0{,}577=-382{,}36$ $^{kJ}/_{mol}$;
$G_{ZnS}=\Delta G°+(G_{Zn}+G_{Srhombic})=-201{,}3+(\mathbf{404{,}657}+\mathbf{3{,}5436})=\mathbf{206{,}9}$ $^{kJ}/_{mol}$;
[1] $\Delta G_{Zn2+}=\Delta H_H-T*\Delta S_H=-33{,}1-298{,}15*-0{,}0146=-382{,}36$ $^{kJ}/_{mol}$;
$G_{S2-}=\Delta G°+(G_{Srhombic}+2G_{e-})=85{,}8+(\mathbf{3{,}5436}+2*\mathbf{14{,}415})=\mathbf{118{,}1736}$ $^{kJ}/_{mol}$;
$2G_{e-}=G_{S2-}-(G_{Srhombic}+\Delta G°)=\mathbf{157{,}63}-(\mathbf{3{,}5436}+85{,}8)=2*\mathbf{34{,}1432}$ $^{kJ}/_{mol}$;
$G_{S2-aq}=G_{Srombic}+\mathbf{G_{H2O}}-(\Delta G_{eqS2-aq})=\mathbf{157.63}$ $^{kJ}/_{mol}$;
[38] $\Delta G_H=\Delta H_H-T*\Delta S_H=-1564{,}8-298{,}15*0{,}19539=-1623$ $^{kJ}/_{mol}$;
$G_{ZnC2O4\bullet 2H2O}=\Delta G°+(G_{Zn}+3G_{O2g}+2G_{graph}+2G_{H2})=\mathbf{321{,}76}$ $^{kJ}/_{mol}$;
$G_{ZnC2O4}=G_{Zn2+}+G_{CO32-}-(\Delta G_{sp}+2G_{H2O})=\mathbf{526{,}0714}$ $^{kJ}/_{mol}$;
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[1] $\Delta G_H=\Delta H_H-T*\Delta S_H=-825{,}1-298{,}15*0{,}0456=-862{,}637$ $^{kJ}/_{mol}$;
$G_{C2O4(2-)}=\Delta G°_{C2O4(2-)Form}+(2G_{Cgr}+2G_{O2}^{gas}+\mathbf{2G_{e-}})=\mathbf{114{,}62}$ $^{kJ}/_{mol}$;
$G_{C2O4(2-)}=\Delta\mathbf{G}°_{C2O4(2-)Form}+(2G_{Cgr}+2G_{O2}^{gas}+G_{e-})=\mathbf{111{,}38}$ $^{kJ}/_{mol}$;
$G_{C2O42-}=\Delta G_{sp}-G_{Zn2+}+(G_{ZnC2O4}+2G_{H2O})=\mathbf{207{,}188}$ $^{kJ}/_{mol}$;
$G_{C2O4}=\Delta G_{eq2HC2O4}-G_{H3O}+(G_{HC2O4}+\mathbf{G_{H2O}})=\mathbf{207{,}173}$ $^{kJ}/_{mol}$;
$G_{C2O4}=2G_{CO2aq}-(\Delta\mathbf{G}_{eqC2O4})=2*\mathbf{18{,}38}-(-\mathbf{146{,}79})=\mathbf{183{,}55}$ $^{kJ}/_{mol}$;

Metal zinc $Zn+H_2O=Zn^{2+}+\mathbf{2e}^-$, $E°_{Classic}=-0{,}7618$ V [1], $-0{,}0591/2*\log(1/([H_2O]))=0{,}0515$ water, sum $\Delta E°$:
$[Zn^{2+}]=C_{ZnSO4}=2$ M solution mas of 2 mols $m_{ZnSO4}=2*161{,}44=322{,}88$ g, density 1,31 $^{g}/_{mL}$. Absolute standard has
$E°_{Zn/Zn2+}=E°_{cclassic}-0{,}0591/2*\log(1/([H_2O]))+\Delta E°=-0{,}7618-0{,}0591/2*\log(1/55{,}3)+0{,}10166-0{,}371339=\mathbf{-0{,}97998}$ V.
$E_{Zn}=E°_{Zn/Zn2+}+0{,}0591/2*\log([Zn^{2+}]/[Zn]/([H_2O]))=\mathbf{-0{,}97998}+0{,}0591/2*\log(2/1/(55{,}3))=-1{,}02258$ V
Distinguish from -1,02258V on 4th digit of -1,02045 V 2M;
Solubility 57,7 $^{g}/_{100g}$ in hundred grams of water; w%=57,7/157,7*100=36,6%;
$m_{H2O}=m_L-m_{ZnSO4}=1310-161{,}44*2=987{,}12$ g; $m_{ZnSO4}=2*161{,}44=$g; $[H_2O]=987{,}12$ $^{g}/18$ $^{g}/_{mol}=54{,}84$ M.
$E_{Zn}=E°_{Zn/Zn2+}+0{,}0591/2*\log([Zn^{2+}]/[Zn]/([H_2O]))=\mathbf{-0{,}97998}+0{,}0591/2*\log(2/1/(54{,}84-4*2))=-1{,}02045$ V;

$\Delta G_{eqZn}=E°_{Zn}\bullet F\bullet 2=\mathbf{-0,980}*96485*2=\mathbf{-189,107}$ kJ/mol;

$\Delta G_{eqZn}=G_{Zn2+}+2G_{e-}-(G_{Zn}+G_{H2O})=\mathbf{215,55}+2*\mathbf{0}-(\mathbf{404,657}+0)=\mathbf{-189,107}$ kJ/mol;

$2G_{e-}=\Delta G_{eqZn}-G_{Zn2+}+(G_{Zn}+G_{H2O})=\mathbf{-189,107-215,55}+(\mathbf{404,657}+0)=\mathbf{0,0}$ kJ/mol;

$G_{Zn}=G_{Zn2+}+2G_{e-}-(\Delta G_{eq\_Zn}+G_{H2O})=\mathbf{215,55}+2*\mathbf{0}-(\mathbf{-189,107}+0)=\mathbf{404,657}$ kJ/mol;

$G_{Zn2+}=\Delta G_{eq\_Zn}-2G_{e-}+(G_{Zn}+G_{H2O})=\mathbf{-189,107}-2*\mathbf{0}+(\mathbf{404,657}+0)=\mathbf{215,55}$ kJ/mol;

Formation [1] $Zn=Zn^{2+}+2e^-$; $\Delta G°=G_{Zn2+}+2G_{e-}-(G_{Zn})=\mathbf{215,55}+2*\mathbf{161,515}-(\mathbf{391,48})=-147,1$ kJ/mol;

$G_{e-}=\Delta G°-G_{Zn2+}+(G_{Zn})=(-147,1-\mathbf{215,55}+(\mathbf{391,48}))/2=\mathbf{14,415}$ kJ/mol;

$G_{Zn2+}=\Delta G°-2G_{e-}+(G_{Zn})=-147,1-2*\mathbf{14,415}+(\mathbf{391,48})=\mathbf{215,55}$ kJ/mol;

Formation [1] $Zn+S_{rhombic}=ZnS$; $G_{Srhombic}=\mathbf{3,5436}$ kJ/mol;

$\Delta G°=G_{ZnS}-(G_{Zn}+G_{Srhombic})=\mathbf{206,9006}-(\mathbf{404,657}+\mathbf{3,5436})=-201,3$ kJ/mol;

$G_{ZnS}=\Delta G°+(G_{Zn}+G_{Srhombic})=-201,3+(\mathbf{404,657}+\mathbf{3,5436})=\mathbf{206,9006}$ kJ/mol;

Formation [1] $S_{rhombic}+2e^-=S^{2-}$; $G_{Srhombic}=\mathbf{3,5436}$ kJ/mol;

$\Delta G°=G_{S2-}-(G_{Srhombic}+2G_{e-})=\mathbf{157,63}-(\mathbf{3,5436}+2*\mathbf{14,415})=85,8$ kJ/mol;

$2G_{e-}=G_{S2-}-(G_{Srhombic}+\Delta G°)=\mathbf{157,63}-(\mathbf{3,5436}+85,8)=2*\mathbf{34,1432}$ kJ/mol;

$G_{S2-}=\Delta G°+(G_{Srhombic}+2G_{e-})=85,8+(\mathbf{3,5436}+2*\mathbf{34,1432})=\mathbf{157,63}$ kJ/mol;

$G_{S2-}=\Delta G°+(G_{Srhombic}+2G_{e-})=85,8+(\mathbf{3,5436}+2*\mathbf{14,415})=\mathbf{118,1736}$ kJ/mol;

$G_{Zn}=\Delta G°+(G_{Zn2+}+2G_{e-})=-147,1+(\mathbf{538,58}+2*0)=\mathbf{391,48}$ kJ/mol;

Formation $Zn+O_{2g}+H_{2g}=Zn(OH)_2$;

$\Delta G°=G_{Zn(OH)2}-(G_{Zn}+G_{O2g}+G_{H2g})=\mathbf{239,897}-(\mathbf{404,657}+\mathbf{303,1}+\mathbf{85,64})=-553,5$ kJ/mol;

$G_{Zn}=G_{Zn(OH)2}-(\Delta G°+G_{O2g}+G_{H2g})=\mathbf{239,897}-(-553,5+\mathbf{303,1}+\mathbf{85,64})=\mathbf{404,657}$ kJ/mol;

$G_{Zn(OH)2}=\Delta G°_{form}+(G_{Zn}+G_{O2}^{gas}+G_{H2}^{gas})=-553,5+(\mathbf{404,657}+\mathbf{303,1}+\mathbf{85,64})=\mathbf{239,897}$ kJ/mol;

[1] Solubility $Zn(OH)_2+3H_2O=Zn^{2+}+2OH^-$; $K_{sp}=[Zn^{2+}]*[OH^-]^2/[H_2O]^3=3*10^{\wedge(-17)}/55,3^{\wedge 3}=10^{\wedge(-25,149)}$;

Attractor $\Delta G_{sp}=-RT\ln(\mathbf{K}_{speq})=-8,3144*298,15*\ln(10^{\wedge(-25,149)})=\mathbf{143,55}$ kJ/mol

$\Delta G_{sp}=G_{Zn2+}+2G_{OH-}-(G_{Zn(OH)2}+3G_{H2O})=\mathbf{228,727}+2*\mathbf{77,36}-(\mathbf{239,897}+3*\mathbf{0})=\mathbf{143,55}$ kJ/mol;

$G_{Zn(OH)2}=G_{Zn2+}+2G_{OH-}-(\Delta G_{sp}+3G_{H2O})=\mathbf{228,727}+2*\mathbf{77,36}-(\mathbf{143,55}+3*\mathbf{0})=\mathbf{239,897}$ kJ/mol;

$G_{Zn2+}=\Delta G_{sp}-2G_{OH-}+(G_{Zn(OH)2}+3G_{H2O})=\mathbf{143,55}-2*\mathbf{77,36}+(\mathbf{239,897}+3*\mathbf{0})=\mathbf{228,727}$ kJ/mol;

Formation $Zn+1,5O_{2g}+C_{graph}=ZnCO_3$;

$\Delta G°=G_{ZnCO3}-(G_{Zn}+1,5G_{O2g}+G_{graph})=\mathbf{219,267}-(\mathbf{404,657}+1,5*\mathbf{303,1}+\mathbf{91,26})=-731,3$ kJ/mol;

$G_{ZnCO3}=\Delta G°_{form}+(G_{Zn}+1,5G_{O2}^{gas}+G_{H2}^{gas})=-731,3+(\mathbf{404,657}+1,5*\mathbf{303,1}+\mathbf{91,26})=\mathbf{219,267}$ kJ/mol;

[1] Solubility $ZnCO_3+2H_2O=Zn^{2+}+CO_3^{2-}$; $K_{sp}=[Zn^{2+}]*[CO_3^{2-}]/[H_2O]^2=1,46*10^{\wedge(-10)}/55,3^{\wedge 2}=10^{\wedge(-13,321)}$;

Attractor $\Delta G_{sp}=-RT\ln(\mathbf{K}_{sp})=-8,3144*298,15*\ln(10^{\wedge(-13,321)})=\mathbf{76,0358}$ kJ/mol;

$\Delta G_{sp}=G_{Zn2+}+G_{CO32-}-(G_{ZnCO3}+2G_{H2O})=\mathbf{404,657}+\mathbf{102,5523}-(\mathbf{431,1735}+2*\mathbf{0})=\mathbf{76,0358}$ kJ/mol;

$G_{ZnCO3}=G_{Zn2+}+G_{CO32-}-(\Delta G_{sp}+2G_{H2O})=\mathbf{404,657}+\mathbf{102,5523}-(\mathbf{76,0358}+2*\mathbf{0})=\mathbf{431,1735}$ kJ/mol;

Formation $1,5O_{2g}+C_{graph}+2e^-=CO_3^{2-}$;

$\Delta G°=G_{CO32-}-(1,5G_{O2g}+G_{graph}+2G_{e-})=\mathbf{46,94}-(1,5*\mathbf{303,1}+\mathbf{91,26}+2*\mathbf{14,415})=-527,8$ kJ/mol;

$G_{CO32-}=\Delta G°+(1,5G_{O2g}+G_{graph}+2G_{e-})=-527,8+(1,5*\mathbf{303,1}+\mathbf{91,26}+2*\mathbf{14,415})=\mathbf{46,94}$ kJ/mol;

Formation $Zn+O_2^{gas}/2+H_2/2=[Zn(OH)]^+$+**e-**; [1]

$\Delta G°=G_{[Zn(OH)]+}+G_{e-}-(G_{Zn}+G_{O2gas}/2+G_{H2}/2)=\mathbf{255,285}+\mathbf{13,642}-(\mathbf{404,657}+\mathbf{303,1}/2+\mathbf{85,64}/2)=-330,1$ kJ/mol;

$G_{e-}=\Delta G°-G_{[Zn(OH)]+}+(G_{Zn}+G_{O2gas}/2+G_{H2}/2)=-330,1-\mathbf{255,285}+(\mathbf{404,657}+\mathbf{303,1}/2+\mathbf{85,64}/2)=\mathbf{13,642}$ kJ/mol;

Acid $[Zn(H_2O)]^{2+}$ protolysis Prigogine atractor $\Delta G_{eq}=-RT\ln(\mathbf{K}_{eq})$ equilibrium [38] IUPAC.

$[Zn(H_2O)]^{2+}+H_2O=[Zn(OH)]^+$+$H_3O^+$; [38] IUPAC.

$K_{eqZn(H2O)2+}=[[Zn(OH)]^+]*[H_3O^+]^2/[[Zn(H_2O)]^{2+}]/[H_2O]=10^{\wedge(-9,15)}/55,3=10^{\wedge(-10,8927)}$;

[38] Attractor $\Delta G_{sp}=-RT\ln(K_{eqZn(H2O)2+})=-8,3144*298,15*\ln(10^{\wedge(-10,8927)})=\mathbf{62,175167}$ kJ/mol;

Hess expression $\Delta G_{prot}=G_{[Zn(OH)]+}+G_{H3O+}-(G_{[Zn(H2O)]2+}+G_{H2O})=\mathbf{255,285}+\mathbf{22,44}-(\mathbf{215,55}+\mathbf{0})=\mathbf{62,175167}$ kJ/mol;

$G_{[Zn(OH)]+}=\Delta G_{prot}-G_{H3O+}+(G_{[Zn(H2O)]2+}+G_{H2O})=\mathbf{62,175167}-\mathbf{22,44}+(\mathbf{215,55}+\mathbf{0})=\mathbf{255,285}$ kJ/mol;

[18] $Zn(H_2O)^{2+}+OH^-=Zn(OH)^++H_2O$;

Stability constant $\mathbf{K}_{stab\_eq}=ß_1*[H_2O]=[Zn(OH)^+]/[Zn^{2+}]/[OH^-]*[H_2O]=10^{\wedge 5,04}*55,3=10^{\wedge 6,782725}$;

[18] Attractor stability $\Delta G_{stab\_eq}=-RT\ln(\mathbf{K}_{stab\_eq})=-8,3144*298,15*\ln(10^{\wedge 6,782725})=\mathbf{-38,715567}$ kJ/mol;

$\Delta G_{stab\_eq}=G_{[Zn(OH)]+}+G_{H2O}-(G_{[Zn(H2O)]2+}+G_{OH-})=\mathbf{254,194}+\mathbf{0}-(\mathbf{215,55}+\mathbf{77,36})=\mathbf{-38,715567}$ kJ/mol;

$G_{[Zn(OH)]+}=\Delta G_{stab\_eq}-G_{H2O}-(G_{[Zn(H2O)]2+}+G_{OH-})=\mathbf{-38,715567}-\mathbf{0}+(\mathbf{215,55}+\mathbf{77,36})=\mathbf{254,194}$ kJ/mol;

Prigogine absolute energy attractors for dissolution, protolysis, and reduction-oxidation of chromium compounds

Metal chromium in $[Cr^{3+}]$=1 M solution, density 1,172 $^{g}/_{mL}$ $m_{H2O}=m_L-m_{Cr2(SO4)2}$=1172-392,16=779,84 g/L, $Cr+H_2O=Cr^{3+}+\mathbf{3e^-}$. molarity $Cr_2(SO_4)_3$=392,16 $^{g}/_{mol}$, water amount $[H_2O]$=779,84 $^{g}/18$ $^{g}/_{mol}$=43,3244 M.
Metal chromium $Cr+H_2O=Cr^{3+}+\mathbf{3e^-}$; has $E°_{classic}$=-0,744 V [1], water -0,0591/3*log(1/(55,3)=0,03433 and ΔE°:
$E°_{Cr/Cr3+}=E°_{Classic}$-0,0591/3*log(1/$[H_2O]$)+$ΔE°_{Cr}$=-0,744+0,03433+0,10166-0,371339=**-0,979347** V.
$\mathbf{\Delta G_{eq\_Cr}}=E°_{Cr}•F•3$=**-0,979347***96485*3=**-283,5** $^{kJ}/_{mol}$,
$\mathbf{\Delta G_{eq\_CR}}=G_{Cr3+}+3G_{e-}-(G_{Cr}+\mathbf{G_{H2O}})$=**18,3**+3***0**-(**301,8**+0)=**-283,5** $^{kJ}/_{mol}$;
$G_{Cr3+}=\mathbf{\Delta G_{eq\_CR}}+(G_{Cr}+\mathbf{G_{H2O}})$=**-283,5**-3***0**+(**301,8**+0)=**18,3** $^{kJ}/_{mol}$;
$3G_{e-}=\mathbf{\Delta G_{eq\_CR}}-G_{Cr3+}+(G_{Cr}+\mathbf{G_{H2O}})$=(**-283,5**)-**18,3**+(**301,8**+0)=3***0** $^{kJ}/_{mol}$;
$E_{Cr}=E°_{Cr}$+0.0591/3*log($[Cr^{3+}]/[Cr]/([H_2O])$)=**-0.979347**+0.0591/3*log(1/1/55.3)=-1.0136 V; Distinguish from 1M -1.0136 V on 3rd digit -1.002 V. Solubility 64 $^{g}/_{100g}$ in hundred grams of water; w%=64/164*100=39.2%; 39.2/100g=X/1172//$^{g}/_{L}$; 39.2/100*1172=459.4 $^{g}/_{L}$; $C_{Cr2(SO4)2}$=459.4/392.16=2.343 M, $Cr_2(SO_4)_3$; $m_{H2O}=m_L-m_{Cr2(SO4)2}$=??1172??-459.4=712.6 g; $m_{Cr2(SO4)2}$=457.07g. $[H_2O]$=712.6 $^{g}/18$ $^{g}/_{mol}$=39.59 M.
$E_{Cr}=E°_{Cr}$+0.0591/3*log($[Cr^{3+}]/([Cr]-([H_2O]-6*[Cr^{3+}])$)=
=**-0.9793**+0.0591/3*log(2.343/1/(39.59-6*1))=-1.002 V;

Substance	$ΔH°_H$ $^{kJ}/_{mol}$	$ΔS°_H$ $^{J}/_{mol/K}$	$ΔG°_H$, $^{kJ}/_{mol}$
G_e Cr	[1] $Cr_2O_7^{2-}$	**28,76975**	**332,515**
Cr	308,90	23,8	**301,8**
Cr assume	zero G_{Cr2O3}=0 $^{kJ}/_{mol}$		**301,8**
Cr^{2+}	-143,5	**-1,13118**	**83,516**
Cr^{2+} G_{e-}	--143,5	formation	**37,392**
Cr^{3+}	$E°_{Cr/Cr3+}$=	**-0,9793** V	**18,3**
$Cr(OH)_{2(s)}$	[33] K_{sp}	$=10^{-20,927}$	**118,785**
$Cr(OH)_3$	[33] K_{sp}	$=10^{-30,2)}$	**38,206**
$Cr(OH)_3$	$E°_{Cr(OH)3/Cr}$	**-1,7497** V	**27,43**
$Cr(OH)_{3aq}$	[18] K_{stab}	9,352*10^{30}	**73,599**
[33]$HCrO_2$	K_{prot}=	10^(-4,92318)	**191,014**
[1] CrO_2^-	$E°_{CrO2-/Cr}$=	**-1,53834V**	**196,675**
$Cr(OH)_4^-$	[33] K_{eq_for}	$=10^{36,874}$	**117,264**
[1] CrO_2	$E°_{CrO2}$=	**2,03428** V	**124,818**
[1]H_2CrO_4	pK_a=0,74	=0,00329	**291,509**
$HCrO_4^{--}$	[1]$E°_{Cr6+3+}$=	**1,45797** V	**283,24**
G_e-$HCrO_4^-$	formation	-736,35	**68,76975**
CrO_4^{2--}	-881,2	50,2	-727,8
2G_e-CrO_4^{2--}	formation	-727,8	**68,76975**
[1] CrO_4^{2--}	pK_{a2}=6,49	$K_e=10^{-8,232}$	**317,7395**
[1] CrO_4^{2--}	$E°_{Cr(OH)3/Cr3+}$=	**-0,53701V**	**269,57**
$Cr_2O_7^{2-}$	-1490,3	261,9	-1301,1
$Cr_2O_7^{2-}$	2G_e-formati	-1301,1	**68,76975**
$Cr_2O_7^{2-}$	formation	-1301,1	**544,83**
[1] $Cr_2O_7^{2-}$	$E°_{Cr2O72-/Cr3}$	**=1,4508** V	**562,32**
$HCr_2O_7^-$	$K_a/[H_2O]$=	0,0002866	**564,538**
$CrCl_{2(s)}$	-395,4	115,3	-356,0
$CrCl_{2(s)}$	-395,4	115,3	-356,0
$CrCl_{3(s)}$	-556,5	123,0	-486,1
$CrCl_{3(s)}$	-556,5	123,0	-486,1
Cr_2O_3	-1139,7	81,2	-1058,1
Cr assum	formation	-1058,1	**301,8**
Cr_2O_3	G_{Cr2O3}=0 $^{kJ}/_{mol}$		**0**
H_2O	-285,85	69,9565	-237,191
OH^-	K_{eq}=3,26•	10^(-18)	**77,36**
OH^-	-230	-10,8	-157,2

G_{O2}^{gas}=**303,1** $^{kJ}/_{mol}$; G_{H2}^{gas}=**85,64** $^{kJ}/_{mol}$; G_{Cgraph}=**91,26** $^{kJ}/_{mol}$;
[1] $2G_{Cr}=G_{Cr2O72-}-(3,5G_{O2g}+\mathbf{\Delta G°_{C2rO72-}}+2G_{e-})$=2***332,515** $^{kJ}/_{mol}$;
[1] $\Delta H_H=\Delta G_{Cl-}+T*\Delta S_H$=**301,8**+298,15*0,0238=308,90 $^{κϑ}/_{μολ}$;
$G_{Cr}=(G_{Cr2O3}-\mathbf{\Delta G°}_{Cr2O3}-1,5G_{O2g})/2$=**301,8** $^{kJ}/_{mol}$;
$G_{Cr2+}=\mathbf{\Delta G_{eq\_CR}}-2G_{e-}+(G_{Cr}+\mathbf{G_{H2O}})$=**83,516** $^{kJ}/_{mol}$;
$2G_{e-}=\mathbf{\Delta G°}-G_{Cr2+}+(G_{Cr})$=-143,5=2***37,392**=-143,5= **29,892** $^{kJ}/_{mol}$;
$G_{Cr3+}=\mathbf{\Delta G_{eq\_CR}}+(G_{Cr}+\mathbf{G_{H2O}})$=**-283,5**+(**301,8**+0)=**18,3** $^{kJ}/_{mol}$;
$G_{Cr(OH)2(s)}=G_{Cr2+}+2\mathbf{G_{OH}}-(\mathbf{\Delta G_{eq}}+3\mathbf{G_{H2O}})$=**118,785** $^{kJ}/_{mol}$;
$G_{Cr(OH)3(s)}=G_{Cr3+}+3\mathbf{G_{OH}}-(\mathbf{\Delta G_{eq}}+4\mathbf{G_{H2O}})$=**38,206** $^{kJ}/_{mol}$;
$G_{Cr(OH)3}=\Delta G°_{eq}-3G_{e-}+(Cr+3\mathbf{G_{OH}})$=**27,43** $^{kJ}/_{mol}$;;
$G_{Cr(OH)3aq}=\mathbf{\Delta G_{eq}}-4\mathbf{G_{H2O}}+(G_{Cr3+}+3\mathbf{G_{OH}}-)$=**73,599** $^{kJ}/_{mol}$;
$G_{HCrO2}=G_{CrO2-}+\mathbf{G_{H3O}}-(\Delta G_{eq}+\mathbf{G_{H2O}})$=**191,014** $^{kJ}/_{mol}$;
$G_{Cr(O2-Cr}=\Delta G°_{eq}-3G_{e-}+2G_{H2O}+(G_{Cr}+4\mathbf{G_{OH}})$=**196,675** $^{kJ}/_{mol}$;
$G_{Cr(OH)4-}=\mathbf{\Delta G_{eq}}-4\mathbf{G_{H2O}}+(G_{Cr3+(H2O)4}+4\mathbf{G_{OH}}-)$=**117,264** $^{kJ}/_{mol}$;
$G_{CrO2}=\mathbf{\Delta G_{eq}}-4G_{H3O}-G_{e-}-(G_{Cr3+}+8G_{H2O})$=**124,818** $^{kJ}/_{mol}$;
$G_{H2CrO4}=G_{HCrO4-}+\mathbf{G_{H3O}}-(\Delta G_{eq}+\mathbf{G_{H2O}})$=**291,509** $^{kJ}/_{mol}$;
$G_{HCrO4}=\mathbf{\Delta G_{eq\_Cr3+/6+}}-7\mathbf{G_{H3O}}-3G_{e-}+(G_{Cr3+}+11\mathbf{G_{H2O}})$=**283,24** $^{kJ}/_{mol}$;
$\mathbf{\Delta G°}_{HCrO4-}=G_{HCrO4-}-(0,5G_{H2}+2\mathbf{G_{O2g}}+G_{Cr}+G_{e-})$=-736,34975 $^{kJ}/_{mol}$;
[1] $\Delta G_H=\Delta H_H-T*\Delta S_H$=-881,2-298,15*0,0502=-896,167 $^{κϑ}/_{μολ}$;
[1] $2G_{e-}=G_{CrO42-}-(G_{Cr}+\mathbf{\Delta G°}+2\mathbf{G_{O2g}})$=2***68,76975** $^{kJ}/_{mol}$;
$G_{CrO42-}=\Delta G_{eq}-\mathbf{G_{H3O}}+(G_{HCrO4}+\mathbf{G_{H2O}})$=**317,7395** $^{kJ}/_{mol}$;
$G_{CrO42-}=\mathbf{\Delta G_{eq}}CrO42-OH--4\mathbf{G_{H2O}}-0-(G_{Cr(OH)3}+5\mathbf{G_{OH}})$=**269,57** $^{kJ}/_{mol}$;
[1] $\Delta G_H=\Delta H_H-T*\Delta S_H$=-1490,3-298,15*0,2619=-1568,385 $^{κϑ}/_{μολ}$;
[1]; $2G_{e-}=G_{Cr2O72-}-(3,5G_{O2g}+2G_{Cr}+\mathbf{\Delta G°}_{Cr2O72-})$=2***68,76975** $^{kJ}/_{mol}$;
$G_{Cr2O7}=\Delta G_D-\mathbf{G_{H2O}}+(2G_{HCrO4})$=**-21,64875**-0+(2***283,24**)=**544,83** $^{kJ}/_{mol}$;
$G_{Cr2O72}=\mathbf{\Delta G_{eq\_CR}}-14G_{H3O}-6G_{e-}+(2G_{Cr3+}+21G_{H2O})$=**562,32** $^{kJ}/_{mol}$;
$G_{HCr2O7-}=G_{Cr2O7}+\mathbf{G_{H3O}}-(\Delta G_{eq}+\mathbf{G_{H2O}})$=**564,538** $^{kJ}/_{mol}$;
[1]
[1]
[1]
[1]
[1] Formation $\mathbf{\Delta G°}_{Cr2O3}=G_{Cr2O3}-(1,5G_{O2g}+2G_{Cr})$=-1058,1 $^{kJ}/_{mol}$;
$G_{Cr}=(G_{Cr2O3}-\mathbf{\Delta G°}_{Cr2O3}-(1,5G_{O2g}))/2$=**301,8** $^{kJ}/_{mol}$;
$G_{Cr2O3}=\mathbf{\Delta G°}_{Cr2O3}+1,5G_{O2g}+2G_{Cr}$=**0** $^{kJ}/_{mol}$;
Protolīze $\Delta G_{eq}=G_{H3O+}+G_{OH-}$=**-22,44**+**77,36**=99,8 $^{kJ}/_{mol}$;
$G_{OH-}=\Delta G_{eq}-G_{H3O+}$=99,8-**22,44**=**77,36** $^{kJ}/_{mol}$;
CRC [1] $\mathbf{\Delta G°}_{OH-}=\Delta H-T*\Delta S$=-230-298.15*-0.0109=-226.75 $^{kJ}/_{mol}$;

$Cr+H_2O=Cr^{2+}+2e^-$, The absolute standard has $E°_{classic}$=-0,913 V [1], water -0,0591/2*log(1/(55,3)=0,0515, sum ΔE°: $E°_{Cr/Cr2+}=E°_{Classic}$-0,0591/2*log(1/[$H_2O$])+$ΔE°_{Cr}$=-0,913+0,0515+0,10166-0,371339=**-1,1311815** V.

$\Delta G_{eq\_Cr}=E°_{Cr}•F•2$=**-1,1311815***96485*2=**-218,284** kJ/mol,

$\Delta G_{eq\_CR}=G_{Cr2+}+2G_{e-}-(G_{Cr}+G_{H2O})$=**83,516**+2***0**-(**301,8**+0)=**-218,284** kJ/mol ;

$G_{Cr2+}=\Delta G_{eq\_CR}-2G_{e-}+(G_{Cr}+G_{H2O})$=**-218,284**-2***0**+(**301,8**+0)=**83,516** kJ/mol ;

$2G_{e-}=\Delta G_{eq\_CR}-G_{Cr2+}+(G_{Cr}+G_{H2O})$=**-218,284-83,516**+(**301,8**+0)=2***0** kJ/mol ;

[1] Formation $Cr=Cr^{2+}+2e^-$, $\Delta G°=G_{Cr2+}+2G_{e-}-(G_{Cr})$=**83,516**+2* G_{e-} -(**301,8**)=-143,5 kJ/mol ;

$2G_{e-}=\Delta G°-G_{Cr2+}+(G_{Cr})$=-143,5-**83,516**+(**301,8**)=2***37,392** kJ/mol ;

$G_{Cr2+}=\Delta G°-2G_{e-}+(G_{Cr})$=-143,5-2***37,392**+(**301,8**)=**83,516** kJ/mol ;

$Cr^{2+}=Cr^{3+}+e^-$. Absolute sum has $E°_{Classic}$=-0,407 V [1], zero water -0,0591/3*log(1)=0,0 un ΔE°:

$E°_{Cr/Cr3+}=E°_{Classic}$-0,0591/1*log(1)+$ΔE°_{Cr}$=-0,407+0,0+0,10166-0,371339=**-0,67668** V.

$\Delta G_{eq\_Cr2+Cr3+}=E°_{Cr2+Cr3+}•F•1$= =**-0,676679***96485*1=**-65,2894** kJ/mol,

$G_{e-}=\Delta G_{eq\_Cr2+Cr3+}-G_{Cr3+}+(G_{Cr2+})$=**-65,2894-18,3**+(**83,516**+0)=**-0,0734** kJ/mol ;

$Cr^{3+}+11H_2O=HCrO_4^-+7H_3O^++3e^-$. Absolute sum has $E°_{Classic}$=1,350 V [1],

-0,0591/3*log(1/([H_2O]^11))= 0,37765 water logarithm and ΔE°:

$E°_{Cr3+/HCrO4}=E°_{Classic}$-0,0591/3*log(1/([$H_2O$]^11))+$ΔE°_{Cr}$=

=1,350-0,0591/3*log(1/(55,3^11))+0,10166-0,371339=**1,45797** V.

$\Delta G_{eq\_Cr3+/HCrO4}=E°_{Cr2+Cr3+}•F•3$=**1,45797** *96485*3=**422,0167** kJ/mol,

$\Delta G_{eq\_Cr3+/HCrO4}=G_{HCrO4}+7G_{H3O}+3G_{e-}-(G_{Cr3+}+11G_{H2O})$=**283,24**+7***22**,44+3***0**-(**18,3**+11***0**)=**422,02** kJ/mol,

$G_{HCrO4}=\Delta G_{eq\_Cr3+/HCrO4}-7G_{H3O}-3G_{e-}+(G_{Cr3+}+11G_{H2O})$=**422,02**-7***22**,44-3***0**+(**18,3**+11***0**)=**283,24** kJ/mol,

$3G_{e-}=\Delta G_{eq\_Cr3+/HCrO4}-G_{HCrO4}-7G_{H3O}++(G_{Cr3+}+11G_{H2O})$=**422,02-283,24**-7***22**,44-3***0**+(**18,3**+11***0**)=3***0** kJ/mol,

$Cr+3OH^-=\underline{Cr(OH)_3}+3e^-$; pH>9 ; Absolute standard has $E°_{classic}$=-1,48 V [1], water 0,137327, sum ΔE°:

$E°_{\underline{Cr(OH)3}/Cr}=E°_{Classic}$-0,0591/3*log(1)+ΔE°=-1,2+0,0+0,10166-0,371339=**-1,74968** V.

$\Delta G_{eq}=E°_{Cr3/\underline{OH}}•F•3$=**-1,74968***96485*3=**-506,45** kJ/mol,

$\Delta G°_{\underline{eq}}=G_{\underline{Cr(OH)3}}+3G_{e-}+(Cr+3G_{OH})$=**27,43**+3***0**-(**301,8**+3*77,36)=**-506,45** kJ/mol;

$G_{\underline{Cr(OH)3}}=\Delta G°_{\underline{eq}}-3G_{e-}+(Cr+3G_{OH})$=**-506,45**-3***0**+(**301,8**+3*77,36)=**27,43** kJ/mol;

$Cr+4OH^-=CrO_2^-+2H_2O+3e^-$; pH>9 ; Absolute standard has $E°_{classic}$=-1,2 V [1], water -0,06866, sum ΔE°:

$E°_{\underline{CrO2-}/Cr}=E°_{Classic}$-0,0591/3*log([$H_2O$]^2)+ΔE°=-1,2-0,0591/3*log(55,3^2)+0,10166-0,371339=**-1,53834** V.

$\Delta G_{eq}=E°_{Cr/\underline{O2-Cr}}•F•3$=**-1,53834***96485*3= **-445,28** kJ/mol,

$\Delta G°_{\underline{eq}}=G_{\underline{CrO2-Cr}}+3G_{e-}+2G_{H2O}-(G_{Cr}+4G_{OH})$=**165,96**+3***0**+2***0**-(**301,8**+4*77,36)=**-445,28** kJ/mol;

$G_{\underline{CrO2-Cr}}=\Delta G°_{\underline{eq}}-3G_{e-}+2G_{H2O}+(G_{Cr}+4G_{OH})$=**-445,28**-3***0**-2***0**+(**301,8**+4*77,36)=**165,96** kJ/mol;

$\Delta G°_{\underline{eq}}=G_{\underline{CrO2-Cr}}+3G_{e-}+2G_{H2O}-(G_{Cr}+4G_{OH})$=**196,675**+3***0**+2***0**-(**332,515**+4*77,36)=**-445,28** kJ/mol;

$G_{\underline{CrO2-Cr}}=\Delta G°_{\underline{eq}}-3G_{e-}+2G_{H2O}+(G_{Cr}+4G_{OH})$=**-445,28**-3***0**-2***0**+(**332,515**+4*77,36)=**196,675** kJ/mol;

$G_{Cr}=G_{\underline{CrO2-Cr}}+3G_{e-}+2G_{H2O}-(\Delta G°_{\underline{eq}}+4G_{OH})$=**196,675**+3***0**+2***0**-(**-445,28**+4*77,36)=**332,515** kJ/mol;

$\underline{Cr(OH)_3}+5OH^-=CrO_4^{2-}+4H_2O+3e^-$; pH>9 ; Absolute standard has $E°_{classic}$=-0,13 V [1], water -0,137326, sum ΔE°:

$E°_{\underline{Cr(OH)3}/Cr3+}=E°_{Classic}$-0,0591/3*log([$H_2O$]^4)+ΔE°=-0,13-0,0591/3*log(55,3^4)+0,10166-0,371339=**-0,53701** V.

$\Delta G_{eq}=E°_{Cr3/\underline{OH}}•F•3$=**-0,5370057***96485*3=**-155,44** kJ/mol,

$\Delta G_{eqCrO42-\underline{OH}}=G_{CrO42-}+4G_{H2O}+3G_{e-}-(G_{\underline{Cr(OH)3}}+5G_{OH})$=**269,566**+4***0**+3***0**-(**38,206**+5*77,36)=**-155,44** kJ/mol;

$G_{CrO42-}=\Delta G_{eqCrO42-\underline{OH}}-4G_{H2O}-3G_{e-}-(G_{\underline{Cr(OH)3}}+5G_{OH})$=**-155,44**-4***0**-3***0**+(**38,206**+5*77,36)=**269,566** kJ/mol;

$\Delta G_{eqCrO42-\underline{OH}}=G_{CrO42-}+4G_{H2O}+3G_{e-}-(G_{\underline{Cr(OH)3}}+5G_{OH})$=**258,79**+4***0**+3***0**-(**27,43**+5*77,36)=**-155,44** kJ/mol;

$G_{CrO42-}=\Delta G_{eqCrO42-\underline{OH}}-4G_{H2O}-3G_{e-}-(G_{\underline{Cr(OH)3}}+5G_{OH})$=**-155,44**-4***0**-3***0**+(**27,43**+5*77,36)=**258,79** kJ/mol;

$Cr^{3+}+8H_2O=CrO_2+4H_3O^++e^-$; Absolute standard has $E°_{classic}$=1,48 V [1], water 0,82396, sum ΔE°:

$E°_{CrO2}=E°_{Classic}$-0,0591/1*log(1/[H_2O]^8)+ΔE°=1,48-0,0591/1*log(1/55,3^8)+0,10166-0,371339=**2,034281** V.

$\Delta G_{eq}=E°_{CrO2}•F•3$=**2,034281***96485*1=**196,278** kJ/mol,

$\Delta G_{eq}=G_{CrO2}+4G_{H3O}+G_{e-}-(G_{Cr3+}+8G_{H2O})$=**124,818**+4***22,44**+**0**-(**18,3**+8*0)=**196,278** kJ/mol ;

$G_{CrO2}=\Delta G_{eq}-4G_{H3O}-G_{e-}-(G_{Cr3+}+8G_{H2O})$=**196,278**-4***22,44**-**0**+(**18,3**+8*0)=**124,818** kJ/mol ;

$2Cr^{3+}+21H_2O=Cr_2O_7^{2-}+14H_3O^{+}+6e^{-}$; Absolute standard has $E°_{classic}$=1,36 V [1], water 0,3604827, sum ΔE°:
$E°_{Cr2O72-/Cr3+}=E°_{Classic}$-0,0591/6*log(1/$[H_2O]^{21}$)+ΔE°=1,36+0,3604827+0,10166-0,371339=**1,450804** V.

$$\Delta G_{eq}=E°_{Cr2O72-/Cr3+}•F•6=\mathbf{1,450804}*96485*6=\mathbf{839,88}\ ^{kJ}/_{mol},$$

$$\Delta G_{eq\_CR}=G_{Cr2O72}+14G_{H3O}+6G_{e-}-(2G_{Cr3+}+21G_{H2O})=\mathbf{562,32}+14*\mathbf{22,44}+6*\mathbf{0}-(2*\mathbf{18,3}+21*0)=\mathbf{839,88}\ ^{kJ}/_{mol};$$

$$G_{Cr2O72}=\Delta G_{eq\_CR}-14G_{H3O}-6G_{e-}+(2G_{Cr3+}+21G_{H2O})=\mathbf{839,88}-14*\mathbf{22,44}+6*\mathbf{0}+(2*\mathbf{18,3}+21*0)=\mathbf{562,32}\ ^{kJ}/_{mol};$$

/wiki/Chromium(III)_chloride Solubility $[[CrCl_2(H_2O)_4]Cl•2H_2O]_{(s)}+2[H_2O]=[CrCl_2(H_2O)_4]^{+}+[Cl^{-}•2H_2O]^{—}$;
$M(CrCl_3•(H_2O)_6)$=158,36+6*18,02=158,36+108,12=266,48 $^{g}/_{mol}$ mas 347,65+237,35=585 $^{g}/_{1000\ mL\ H2O}$.
108,12/266,48=X/585; 108,12/266,48*585=X=237,35mL; $[H_2O]$=(1000+237,35)/18,02=68,665 mol 1237,35 mL
347,65/1237,35=X/1000; 347,65/1237,35*1000=280,96g/1000 g, w%=280,96/(280,96+1000)*100=22,696%;
$[CrCl_2(H_2O)_4]Cl•2H_2O$=280,96/158,36=1,774 M=$[Cr^{3+}]=[Cl^{-}•2H_2O]$ m=280,96+1000=1280,96 g=? volume
$[H_2O]$=(1000/18,02)=55,494 M ; $[H_2O]$=55,494-4*1,774-2*1,774=44,85 M in 1000

$[[CrCl_2(H_2O)_4]Cl•2H_2O]_{(s)}+2[H_2O]=[CrCl_2(H_2O)_4]^{+}+[Cl^{-}•2H_2O]^{—}$; mol fraction constant unit less :

$$K_{sp\_eq}=[[CrCl_2(H_2O)_4]^{+}]*[[Cl^{-}•2H_2O]^{—}]/[[[CrCl_2(H_2O)_4]Cl•2H_2O]_{(s)}]/[H_2O]^2=1,774^{\wedge 2}/1/44,85^{\wedge 2}=0,0015645;$$

Sum for mol fraction $[[CrCl_2(H_2O)_4]^{+}]+[Cl^{-}•2H_2O]+[H_2O]$=1,774+1,774+44,85=48,398 M;

$$\Delta G_{eq}=\mathbf{-R•T•}\ln(\mathbf{K}_{eq})=-8,3144*298,15*\ln(0,0015645)=\mathbf{16,0144}\ ^{kJ}/_{mol}.$$

$$\Delta G_{eq}=G_{[CrCl2(H2O)4]+}+G_{[Cl-•2H2O]—}-(G_{[[CrCl2(H2O)4]Cl•2H2O](s)}+2G_{H2O})=\mathbf{16,0144}\ ^{kJ}/_{mol};$$

$$\Delta G_{eq}=G_{[CrCl2(H2O)4]+}+G_{[Cl-•2H2O]—}-(G_{[[CrCl2(H2O)4]Cl•2H2O](s)}+2G_{H2O})=\mathbf{16,0144}\ ^{kJ}/_{mol};$$

Formation $\Delta G°_{CrCl3}=G_{CrCl3}-(G_{Cr}+1,5G_{Cl2})=G_{CrCl3}-(\mathbf{301,8}+1,5*G_{Cl2})$=-486,1 $^{kJ}/_{mol}$;

$[[CrCl_2(H_2O)_4]Cl•2]_{(s)}$=1, $[Cr^{3+}]$=1,774 M, $[Cl^{-}•2H_2O]$=1,774 M, $[H_2O]$=44,85 M

[33] Solubility $[Cr^{3+}(H_2O)_3(OH)_3]_{(s)}+4H_2O=[Cr^{3+}(H_2O)_6]+3OH$; $K_{sp}=10^{\wedge(-30,2)}$;

$$K_{eq}=K_{sp}/[H_2O]^4=6,3*10^{\wedge(-31)}/55,3^{\wedge}4=10^{\wedge(-37,17155)};$$

$$\Delta G_{eq}=\mathbf{-R•T•}\ln(K_{eq})=-8,3144*298,15*\ln(10^{\wedge(-37,17155)})=\mathbf{212,174}\ ^{kJ}/_{mol}.$$

$$\Delta G_{eq}=G_{Cr3+}+3\mathbf{G}_{OH}-(G_{Cr(OH)3(s)}+\mathbf{4G_{H2O}})=G_{Cr3+}+3*\mathbf{77,36}-(G_{Cr(OH)3(s)}+*4*0)=\mathbf{212,174}\ ^{kJ}/_{mol};$$

$$G_{Cr(OH)3(s)}=G_{Cr3+}+3\mathbf{G}_{OH}-(\Delta\mathbf{G}_{eq}+\mathbf{4G_{H2O}})=\mathbf{18,3}+3*\mathbf{77,36}-(\mathbf{212,174}+4*0)=\mathbf{38,206}\ ^{kJ}/_{mol};$$

[18] Stability $Cr^{3+}+3OH=Cr(OH)_3+4H_2O$;

$K_{stab}=ß3*[H_2O]^4=[Cr(OH)_3]/([Cr^{3+}]/[OH^{-}]^3)*[H_2O]^4=10^{\wedge 24}*55,3^{\wedge 4}=9,3519*10^{\wedge 30}$ $10^{\wedge 24}$ [I]=0; $10^{\wedge 22}$ [I]=1 M;

$$\Delta G_{eq}=\mathbf{-R•T•}\ln(K_{stab})=-8,3144*298,15*\ln(9,3519*10^{\wedge 30})=\mathbf{-176,7807}\ ^{kJ}/_{mol}.$$

$$\Delta G_{eq}=G_{Cr(OH)3aq}+4\mathbf{G_{H2O}}-(G_{Cr3+}+3\mathbf{G}_{OH-})=\mathbf{73,599}+4*0-(\mathbf{18,3}+3*\mathbf{77,36})=\mathbf{-176,7807}\ ^{kJ}/_{mol};$$

$$G_{Cr(OH)3aq}=\Delta\mathbf{G}_{eq}-4\mathbf{G_{H2O}}+(G_{Cr3+}+3\mathbf{G}_{OH-})=\mathbf{-176,7807}-4*0+(\mathbf{18,3}+3*\mathbf{77,36})=\mathbf{73,599}\ ^{kJ}/_{mol};$$

[33] Complex formation $[Cr^{3+}]$+EDTA=[Cr(EDTA)]+H_2O; $K_{eq}=K_f*[H_2O]=1*10^{\wedge 23}*55,3=5,53*10^{\wedge 24}$;

$$\Delta G_{eq}=\mathbf{-R•T•}\ln(K_{eq})=-8,3144*298,15*\ln(5,53*10^{\wedge 24})=\mathbf{-141,23}\ ^{kJ}/_{mol}.$$

[18] Complex formation $[Cr^{3+}]$+EDTA=[Cr(EDTA)]+H_2O; $K_{eq}=K_f*[H_2O]=10^{\wedge 23,4}*55,3=1,389*10^{\wedge 25}$;

$$\Delta G_{eq}=\mathbf{-R•T•}\ln(K_{eq})=-8,3144*298,15*\ln(1,389*10^{\wedge 25})=\mathbf{-143,5137}\ ^{kJ}/_{mol},$$

[33] Complex formation $[Cr^{3+}(H_2O)_4]+4OH=[Cr(OH)_4]+4H_2O$;

$$K_{eq\_for}=K_{for}*[H_2O]^{\wedge 4}=8*10^{\wedge 29}*55,3^{\wedge 4}=10^{\wedge 36,874};$$

$$\Delta G_{eq}=\mathbf{-R•T•}\ln(K_{eq\_for})=-8,3144*298,15*\ln(10^{\wedge 36,874})=\mathbf{-210,476}\ ^{kJ}/_{mol}.$$

$$\Delta G_{eq}=G_{Cr(OH)4-}+4\mathbf{G_{H2O}}-(G_{Cr3+(H2O)4}+4\mathbf{G}_{OH-})=\mathbf{117,264}+4*0-(\mathbf{18,3}+4*\mathbf{77,36})=\mathbf{-210,476}\ ^{kJ}/_{mol};$$

$$G_{Cr(OH)4-}=\Delta\mathbf{G}_{eq}-4\mathbf{G_{H2O}}+(G_{Cr3+(H2O)4}+4\mathbf{G}_{OH-})=\mathbf{-210,476}-4*0+(\mathbf{18,3}+4*\mathbf{77,36})=\mathbf{117,264}\ ^{kJ}/_{mol};$$

[33] Solubility $Cr(OH)_{2(s)}+3H_2O=Cr^{2+}+2OH^{-}$; $K_{sp}=[Cr^{2+}]*[OH^{-}]^2/[Cr(OH)_{3(s)}]=2*10^{-16}$; $^{-20,927}$

$$K_{eq}=K_{sp}/[H_2O]^3=[Cr^{2+}]*[OH^{-}]^2/[Cr(OH)_{2(s)}]/[H_2O]^3=2*10^{\wedge(-16)}/55,3^{\wedge 3}=1,18264555*10^{\wedge(-21)}=10^{\wedge(-20,927)};$$

$$\Delta G_{eq}=\mathbf{-R•T•}\ln(\mathbf{K}_{eq})=-8,3144*298,15*\ln(10^{\wedge(-20,927)})=\mathbf{119,451}\ ^{kJ}/_{mol}.$$

$$\Delta G_{eq}=G_{Cr2+}+2\mathbf{G}_{OH-}-(G_{Cr(OH)2(s)}+3\mathbf{G_{H2O}})=\mathbf{83,516}+2*\mathbf{77,36}-(\mathbf{118,785}+3*0)=\mathbf{119,451}\ ^{kJ}/_{mol};$$

$$G_{Cr(OH)2(s)}=G_{Cr2+}+2\mathbf{G}_{OH-}-(\Delta\mathbf{G}_{eq}+3\mathbf{G_{H2O}})=\mathbf{83,516}+2*\mathbf{77,36}-(\mathbf{119,451}+3*0)=\mathbf{118,785}\ ^{kJ}/_{mol};$$

[1] Formation $2Cr+1,5O_2=Cr_2O_3$; $\Delta\mathbf{G}°_{Cr2O3}=G_{Cr2\mathbf{O3}}-(1,5G_{\mathbf{O2}g}+2G_{Cr})=0-(1,5*\mathbf{303}+2G_{Cr})$=-1058,1 $^{kJ}/_{mol}$;

$$G_{Cr}=(G_{Cr2\mathbf{O3}}-\Delta\mathbf{G}°_{Cr2O3}-(1,5G_{\mathbf{O2}g}))/2=(0+1058,1-(1,5*\mathbf{303}))/2=\mathbf{301,8}\ ^{kJ}/_{mol};$$

$$G_{Cr2\mathbf{O3}}=-\Delta\mathbf{G}°_{Cr2O3}+1,5G_{\mathbf{O2}g}+2G_{Cr})=1058,1-1,5*\mathbf{303}-2*\mathbf{301,8})=0\ ^{kJ}/_{mol};$$

[1] Formation $Cr+2O_2+2\mathbf{e}^{-}=CrO_4^{2-}$;

$$\Delta\mathbf{G}°=G_{CrO42-}-(G_{Cr}+2G_{e-}+2G_{\mathbf{O2}g})=\mathbf{317,7395}-(\mathbf{301,8}+2*\mathbf{68,76975}+2*\mathbf{303,1})=-727,8\ ^{kJ}/_{mol};$$

$$2G_{e-}=G_{CrO42-}-(G_{Cr}+\Delta\mathbf{G}°+2G_{\mathbf{O2}g})=\mathbf{317,7395}-(\mathbf{301,8}-727,8+2*\mathbf{303,1})=2*\mathbf{68,76975}=\mathbf{137,5395}\ ^{kJ}/_{mol};$$

[1] Formation $0,5H_2+2O_2+Cr+\mathbf{e}^{-}=HCrO_4^{-}$;

$\Delta\mathbf{G}°_{HCrO4-}=G_{HCrO4-}-(0,5G_{H2}+2G_{\mathbf{O2}g}+G_{Cr}+G_{e-})=\mathbf{283,24}-(0,5*\mathbf{85,64}+2*\mathbf{303,1}+\mathbf{301,8}+\mathbf{68,76975})$=-736,34975 $^{kJ}/_{mol}$;

$G_{e-}=G_{HCrO4-}-(0,5G_{H2}+2G_{\mathbf{O2}g}+G_{Cr}+\Delta\mathbf{G}°_{HCrO4-})=\mathbf{283,24}-(0,5*\mathbf{85,64}+2*\mathbf{303,1}+\mathbf{301,8}-736,34975)=\mathbf{68,76975}\ ^{kJ}/_{mol}$;

[1] Formation $H_2+2O_2+Cr=H_2CrO_4$;

$\Delta G^o_{H2CrO4}=G_{H2CrO4}-(G_{H2}+2G_{O2g}+G_{Cr})=\mathbf{291,509}-(\mathbf{85,64}+2*\mathbf{303,1}+G_{Cr})=-727,8$ kJ/mol;

$\Delta G^o_{H2CrO4}=G_{H2CrO4}-(G_{H2}+2G_{O2g}+G_{Cr})=\mathbf{291,509}-(\mathbf{85,64}+2*\mathbf{303,1}+G_{Cr})=-727,8$ kJ/mol;

[1] Formation $3,5O_2+2Cr+2e^-=Cr_2O_7^{2-}$;

$\Delta G^o_{Cr2O72-}=G_{Cr2O72-}-(3,5G_{O2g}+2G_{Cr}+2G_{e-})=\mathbf{562,32}-(3,5*\mathbf{303,1}+2*\mathbf{332,515}+2*\mathbf{68,76975})=-1301,1$ kJ/mol;

$2G_{Cr}=G_{Cr2O72-}-(3,5G_{O2g}+\Delta G^o_{C2rO72-}+2G_{e-})=\mathbf{562,32}-(3,5*\mathbf{303,1}-1301,1+2*\mathbf{68,76975}=2*\mathbf{332,515}=\mathbf{665,0305}$ kJ/mol;

$2G_{e-}=G_{Cr2O72-}-(3,5G_{O2g}+2G_{Cr}+\Delta G^o_{Cr2O72-})=\mathbf{562,32}-(3,5*\mathbf{303,1}+2*\mathbf{332,515}-1301,1)=2*\mathbf{68,76975}$ kJ/mol;

[1] Protolysis $pK_a=0,74$; $H_2CrO_4+H_2O=HCrO_4^-+H_3O^+$; $K_{eq}=K_a/[H_2O]=10^{\wedge(-0,74)}/55,3=0,003290598$;

$\Delta G_{eq}=-R\bullet T\bullet\ln(K_a/[H_2O])=-8,3144*298,15*\ln(0,18197/55,3)=\mathbf{14,171}$ kJ/mol ;

$\Delta G_{eq}=G_{HCrO4-}+G_{\mathbf{H3O}}-(G_{H2CrO4}+G_{\mathbf{H2O}})=\mathbf{283,24}+\mathbf{22,44}-(\mathbf{291,509}+\mathbf{0})=\mathbf{14,171}$ kJ/mol ;

$G_{H2CrO4}=G_{HCrO4-}+G_{\mathbf{H3O}}-(\Delta G_{eq}+G_{\mathbf{H2O}})=\mathbf{283,24}+\mathbf{22,44}-(\mathbf{14,171}+\mathbf{0})=\mathbf{291,509}$ kJ/mol ;

[1] Protolysis $pK_{a2}=6,49$; $HCrO_4^-+H_2O=CrO_4^{2-}+H_3O^+$; $K_{eq}=K_{a2}/[H_2O]=10^{\wedge}(-6,49)/55,3=10^{\wedge(-8,2327)}$;

$\Delta G_{eq}=-R\bullet T\bullet\ln(K_{a2}/[H_2O])=-8,3144*298,15*\ln(5,8516*10^{\wedge(-9)}/55,3)=\mathbf{56,9395}$ kJ/mol;

$\Delta G_{eq}=G_{CrO42-}+G_{\mathbf{H3O}}-(G_{HCrO4}+G_{\mathbf{H2O}})=317,7395+\mathbf{22,44}-(\mathbf{283,24}+\mathbf{0})=\mathbf{56,9395}$ kJ/mol;

$G_{CrO42-}=\Delta G_{eq}-G_{\mathbf{H3O}}+(G_{HCrO4}+G_{\mathbf{H2O}})=\mathbf{56,9395}-\mathbf{22,44}+(\mathbf{283,24}+\mathbf{0})=\mathbf{317,7395}$ kJ/mol;

[33] Protolysis $Cr(OH)_3=HCrO_2+H_2O=CrO_2^-+H_3O^+$;

$K_a=6,6*10^{\wedge(-4)}$; $K_{prot}=K_a/[H_2O]=6,6*10^{\wedge(-4)}/55,3=1,19349*10^{\wedge(-5)}=10^{\wedge(-4,92318)}$;

$\Delta G_{eq}=-R\bullet T\bullet\ln(K_a/[H_2O])=-8,3144*298,15*\ln(1,19349*10^{\wedge(-5)})=\mathbf{28,10135}$ kJ/mol;

$\Delta G_{eq}=G_{CrO2-}+G_{\mathbf{H3O}}-(G_{HCrO2}+G_{\mathbf{H2O}})=\mathbf{196,675}+\mathbf{22,44}-(\mathbf{191,014}+\mathbf{0})=\mathbf{28,10135}$ kJ/mol;

$G_{HCrO2}=G_{CrO2-}+G_{\mathbf{H3O}}-(\Delta G_{eq}+G_{\mathbf{H2O}})=\mathbf{196,675}+\mathbf{22,44}-(\mathbf{28,10135}+\mathbf{0})=\mathbf{191,014}$ kJ/mol;

[39] https://en.wikipedia.org/wiki/Chromic_acid

Dissociation ; $2HCrO_4^-=Cr_2O_7^{2-}+H_2O$; $\log K_D=2,05$;

$K_{eq}=K_D*[H_2O]=[Cr_2O_7^{2-}]/[HCrO_4^-]^{\wedge 2}*[H_2O]=10^{\wedge 2,05}*55,3=10^{\wedge 3,792725}=6204,76$;

$0,74<$ pH <6; $\Delta G_D=-R\bullet T\bullet\ln(K_D*[H_2O])=-8,3144*298,15*\ln(6204,76)=\mathbf{-21,64875}$ kJ/mol ;

$\Delta G_D=G_{Cr2O7}+G_{\mathbf{H2O}}-(2G_{HCrO4})=\mathbf{544,83}+\mathbf{0}-(2*\mathbf{283,24})=\mathbf{-21,65}-0+(2*\mathbf{283,24})=\mathbf{-21,64875}$ kJ/mol ;

$G_{Cr2O7}=\Delta G_D-G_{\mathbf{H2O}}+(2G_{HCrO4})=\mathbf{-21,64875}-0+(2*\mathbf{283,24})=\mathbf{544,83}$ kJ/mol ;

[39] https://en.wikipedia.org/wiki/Chromic_acid

Protolysis ; $pK_a=1,8$; $HCr_2O_7^-+H_2O=Cr_2O_7^{2-}+H_3O^+$;

$K_{eq}=K_a/[H_2O]=10^{\wedge(-1,8)}/55,3=0,0002865991$;

$\Delta G_{eq}=-R\bullet T\bullet\ln(K_{eq})=-8,3144*298,15*\ln(0,0002865991)=\mathbf{20,22175}$ kJ/mol;

$\Delta G_{eq}=G_{Cr2O7}+G_{\mathbf{H3O}}-(G_{HCr2O7-}+G_{\mathbf{H2O}})=\mathbf{562,32}+\mathbf{22,44}-(G_{HCr2O7-}+\mathbf{0})=\mathbf{20,22175}$ kJ/mol;

$G_{HCr2O7-}=G_{Cr2O7}+G_{\mathbf{H3O}}-(\Delta G_{eq}+G_{\mathbf{H2O}})=\mathbf{562,32}+\mathbf{22,44}-(\mathbf{20,22175}+\mathbf{0})=\mathbf{564,538}$ kJ/mol;

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