Hydrogen metal **H(Pt)** absolute electrode potential discovery at H_3O^+ solution. [25]

The biosphere attractor pH=7.36 plays a centripetal role in maintaining the complex reactions (processes) of perfect order homoeostasis. In current article have been extrapolated on to attractor value of pH=7.36 the free energy values from Alberty calculation tables at pH 5, 6, 7, 8, 9. Respecting the pH=7.36, the hydrogen gas G_{H2}^{gas}=**85,64** $^{kJ}/_{mol}$ and the free energy of saturated hydrogen solution G_{H2aq}=**103,24** $^{kJ}/_{mol}$ are given. [8]

Water formation $\mathbf{H_2^{gas}}+\mathbf{O_2}^{gas}/2=\mathbf{H_2O}$ from free elements standard change is $\Delta\mathbf{G}°_{H2O}$=-237,191 $^{kJ}/_{mol}$

calculate $\Delta\mathbf{G}°_{H2O}=G_{\mathbf{H2O}}-(G_{H2}^{gas}+G_{\mathbf{O2}}^{gas}/2)=\mathbf{0}-(\mathbf{85,64}+G_{\mathbf{O2}}^{gas}/2)$=-237,191 $^{kJ}/_{mol}$

with Alberty' data [8] gives the free energy content per mole of gaseous oxygen $G_{\mathbf{O2}}$=**303,1** $^{kJ}/_{mol}$

$G_{\mathbf{O2}}^{gas}=(G_{\mathbf{H2O}}-(G_{H2}^{gas}+\Delta\mathbf{G}°_{H2O}))*2=(\mathbf{0}-(\mathbf{85,64}-237,191))*2=\mathbf{303,1}$ $^{kJ}/_{mol}$. [1,15]

During the formation of $\mathbf{H_2^{gas}}$ and $\mathbf{O_2}^{gas}/2$, energy was spontaneously lost to the zero value of water $G_{\mathbf{H2O}}$=**0** $^{kJ}/_{mol}$.

Since the 1920 Nobel Prize in Chemistry, the classical standard potential of the hydrogen electrode, forming the classical zero reference of the scale. [1] Zero is an unusual standard potential $E_{o\_classic}$=0 Volts for a metal, as the reducing agents accumulate free electrons in superiority negative cathode, forming $\mathbf{E}_{classic}$<0 Volts a negative potential, while the oxidizers capture free electrons leaving in the minority positive anode, a positive potential $\mathbf{E}_{classic}$>0 Volts. The accounting for hydroxonium and water is critically necessary for the assessment of the active masses law and the Prigogine constant under logarithm of attractor expression, since all non-equilibrium states tend to the Prigogine attractor, which has only one unique value to strive for $\Delta\mathbf{G}_{eq}=-\mathbf{R}\bullet\mathbf{T}\bullet\ln(\mathbf{K}_{eq})=\mathbf{E}°\mathbf{nF}$. [2]

The classical Nernst equation $\underline{\mathbf{H(Pt)}}=\mathbf{H^+}+\mathbf{e^-}$; for metallic hydrogen is expressed under standard conditions, the concentration in mol fraction of the pure metal is one $[\underline{\mathbf{H(Pt)}}]$=1 in solution [H+]=1 M of sulfuric acid. The equilibrium constant is one $\mathbf{K}_{classic\mathbf{H(Pt)}}=[\mathbf{H^+}]/[\underline{\mathbf{H(Pt)}}]$=1 M/1=1 M but with the unit of measurement molarity 1 M:

$\mathbf{E}_{classic}=E_{o\_classic}+0{,}0591\bullet\log\mathbf{K}_{classic\mathbf{H(Pt)}}=0+0{,}0591\bullet\log[\mathbf{H^+}]=0+0{,}0591\bullet\log(1\text{ M})=0$ Volts. [1]

The standard electrode for the Nernst hydrogen oxidation reaction $\underline{\mathbf{H(Pt)}}+\mathbf{H_2O}=\mathbf{H_3O^+}+\mathbf{e^-}$.

The Prigogine attractor $\Delta\mathbf{G}_{eq\mathbf{H(Pt)}}=-\mathbf{R}\bullet\mathbf{T}\bullet\ln(\mathbf{K}_{eq\mathbf{H(Pt)}})=\mathbf{E}°\mathbf{nF}$ in mathematics uses the equilibrium constant $\mathbf{K}_{eq\mathbf{H(Pt)}}$ without units (as unitless mol fractions) should be used also for $\Delta\mathbf{G}_{\mathbf{H(Pt)}}=-\mathbf{R}\bullet\mathbf{T}\bullet\ln(\mathbf{K}_{\mathbf{H(Pt)}})=E\mathbf{nF}$ non-equilibrium states. All non-equilibrium states $\Delta\mathbf{G}_{\mathbf{H(Pt)}}=-\mathbf{R}\bullet\mathbf{T}\bullet\ln(\mathbf{K}_{\mathbf{H(Pt)}})=E\mathbf{nF}$ tend to the equilibrium state $|\Delta\mathbf{G}_{\mathbf{H(Pt)}}|>|\Delta\mathbf{G}_{eq\mathbf{H(Pt)}}|$ as absolute and unique minimum of the free energy change $|\Delta\mathbf{G}_{eq\mathbf{H(Pt)}}|$. [3] The free electron concentration [e] and the number of electrons in the electrochemical reaction n are included in the expression of the standard potential **E°**. The Classical standard potential is determined experimentally against the hydrogen standard electrode Classical zero =0 Volts. To use the absolute free energy scale, it is necessary to determine the absolute standard potential $E^\circ_H=\Delta\mathbf{G}_{eqH(Pt)}/F/n=\mathbf{-26,12}/96485/1$=-0.27073 Volts of the standard hydrogen electrode $\underline{\mathbf{H(Pt)}}+\mathbf{H_2O}=\mathbf{H_3O^+}+\mathbf{e^-}$.

In the Nernst oksidation reaction of the standard electrode of hydrogen, the reactant hydrogen metal in the platinum crystal lattice and the water molecule are in the reduced form $Red(\underline{\mathbf{H(Pt)}}+H_2O)$, which donates an electron to the electron gas, charging it negatively $\underline{\mathbf{H(Pt)}}+H_2O=H_3O^+\mathbf{+e^-}$; and in the products the oxidized form $Ox^{\Delta n+}(H_3O^+)$ hydroxonium ion with a negative charge in the metal electron gas.

The standard potential forms the Prigogine attractor $\Delta G_{eq}=\mathbf{E}°\mathbf{nF}=-\mathbf{R}\bullet\mathbf{T}\bullet\ln(\mathbf{K}_{eq})=\Delta G°Ox^{\Delta n+}-\Delta G°_{Red}$ minimum of the free energy change at equilibrium for hydrogen $\Delta G_{eq}=\mathbf{E}°\mathbf{nF}=-\mathbf{R}\bullet\mathbf{T}\bullet\ln(\mathbf{K}_{eq})=\Delta G°_{H3O+}-(\Delta G°_{H2O}+\Delta G°_{\underline{\mathbf{H(Pt)}}})$; The standard potential $\Delta\mathbf{G}_{eqH(Pt)}=E^\circ_H\bullet F\bullet n=-0.27073*96485*1=\mathbf{-26,12}$ $^{kJ}/_{mol}$ coincide with Hess's calculation based on Alberty' data $\Delta\mathbf{G}_{eqH(Pt)}=G_{H3O+}+G_{e-}-(G_{\mathbf{H(Pt)}}+G_{\mathbf{H2O}})=22{,}44+0-(\mathbf{48,56}+0)=\mathbf{-26,12}$ $^{kJ}/_{mol}$.

When established equilibrium, the sum of the chemical potentials of reactants the reducing agents and of products the oxidizing agents plus the electrons are equal $\mu Red+EnF=\mu Ox^{\Delta n+}+n\mu e-$. For each substance, the chemical potential can be calculated as $\mu=\Delta G°_A+RT\ln(N_A)$, where N_A is the concentration of substance A in mole fractions and $\Delta G°_A$ is the standard free energy change of a given substance A at formation from free elements. For example, $\mathbf{H_2O}$ formation

$\mathbf{H_2^{gas}}+\mathbf{O_2}^{gas}/2=\mathbf{H_2O}$; from the elements the published standard change is $\Delta\mathbf{G}°_{H2O}$=-237,191 $^{kJ}/_{mol}$ [1]:

$\Delta\mathbf{G}°_{H2O}=G_{\mathbf{H2O}}-(G_{H2}^{gas}+G_{\mathbf{O2}}^{gas}/2)=\mathbf{0}-(\mathbf{85,64}+\mathbf{303,1}/2)$=-237,191 $^{kJ}/_{mol}$.

$\mathbf{H_3O^+}$ formation $1{,}5\mathbf{H_2^{gas}}+\mathbf{O_2}^{gas}/2=\mathbf{H_3O^+}+\mathbf{e^-}$;

The electron free energy content Ge is Hess standard formation reaction from free elements $\mathbf{e^-}$, $\mathbf{H_2^{gas}}$, $\mathbf{O_2}^{gas}$:

$\Delta\mathbf{G}°_{H3O+}=G_{\mathbf{H3O}}+G_{\mathbf{e-}}-(1{,}5G_{H2aq}+G_{\mathbf{O2}aq}/2)=\mathbf{22{,}4}+\mathbf{26{,}121}-(1{,}5*\mathbf{85{,}64}+\mathbf{303{,}1}/2)$=-231,3887 $^{kJ}/_{mol}$;

Free electron formation energy content in one mol is

$G_{e-}=\Delta\mathbf{G}°_{H3O+}-G_{H3O+}+(1{,}5*G_{H2}^{gas}+0{,}5*G_{\mathbf{O2}}^{gas})=-231{,}3887-\mathbf{22{,}44}+(1{,}5*\mathbf{85{,}6}+\mathbf{303{,}1}/2)=\mathbf{26{,}121}$ $^{kJ}/_{mol}$.

$\mathbf{OH^-}$ formation $\mathbf{H_2^{gas}}/2+\mathbf{O_2}^{gas}/2)+\mathbf{e^-}=\mathbf{OH^-}$;

$\Delta\mathbf{G}°_{OH-}=G_{\mathbf{OH-}}-(G_{H2}^{gas}/2+G_{\mathbf{O2}aq}/2+G_{\mathbf{e-}})=\mathbf{77.36}-(\mathbf{85,64}/2+\mathbf{303,1}/2+\mathbf{40,19})$=-157,2 $^{kJ}/_{mol}$;

$G_{\mathbf{e-}}=G_{\mathbf{OH-}}-(G_{H2}^{gas}/2+G_{\mathbf{O2}aq}/2+\Delta\mathbf{G}°_{OH-})=\mathbf{77.36}-(\mathbf{85,64}/2+\mathbf{303,1}/2-157{,}2)=\mathbf{40,19}$ $^{kJ}/_{mol}$;

In the equilibrium mixture, $\Delta G°_{Red}+\mathbf{E}°\mathbf{nF}=\Delta G°Ox^{\Delta n+}+\mathbf{n}\Delta G°e-$ the change in the free energy of formation in the Hessian equation contains $\Delta G°Ox^{\Delta n+}$, $\Delta G°Red$ the product ratio of oxidants over reductants $N_{Ox}^{\Delta n+}/N_{Red}$=1

under the logarithmic sign one, therefore $R*T/n/F*\ln(N_{Ox}^{\Delta n+}/N_{Red})=0$ is zero. The sum of the electrode potentials E includes the standard potential E°. Free electrons are not bound in compounds $\Delta G°_{e-}=0$ $^{kJ}/_{mol}$. Concentration of free electrons [e]=1 not shown: $E=\frac{\Delta G°_{Ox^{\Delta n+}}-\Delta G°_{Red}}{nF}+\frac{RT}{nF}\bullet\ln\left(\frac{N_{Ox^{\Delta n+}}}{N_{Red}}\right)=E°+\frac{RT}{nF}\bullet\ln\left(\frac{N_{Ox^{\Delta n+}}}{N_{Red}}\right)$.

The standard potential $\mathbf{E°}=\frac{\Delta G°_{Ox^{\Delta n+}}-\Delta G°_{Red}}{nF}$ in the Prigogine attractor is the change minimum of free energy at equilibrium state $\Delta G_{eq}=\mathbf{E°nF}=\mathbf{-R\bullet T\bullet\ln(K_{eq})}=\Delta G°_{Ox}^{\Delta n+}-\Delta G°_{Red}$. By switching to decimal logarithms and the thermodynamic standard T=298.15 K, we have the Nernst equation for the electrochemical oxidation reaction $\underline{\mathbf{H}}\mathbf{(Pt)}+\mathbf{H_2O}=\mathbf{H_3O^+}+\mathbf{e^-}$ in $[H_2SO_4]=[H_3O^+]=1$ M unimolar solution:

$$E=\mathbf{E°}+0{,}0591/n*\log([\mathbf{H_3O^+}]*[\mathbf{e^-}]/[\mathbf{H_2O}]/[\mathbf{H(Pt)}])=\mathbf{-0{,}27073}+0{,}0591/n*\log(1\text{ M}*1/52.5\text{ M}/1).$$

Of products / reactants ratio Oxidized form =$\underline{\mathbf{Ox}}^{\Delta n+}$+on- $\underline{\mathbf{Red}}$uced form due to logarithm one is zero.
Absolute standard hydrogen electrode potential is $\mathbf{E°}_H$=**-0.27073** Volts instead of arbitrarly taken classic zero:

$$\mathbf{E°}_{H\_classic}+0{,}0591\bullet\log\mathbf{K}_{classic\mathbf{H(Pt)}}=0+0{,}0591\bullet\log[\mathbf{H^+}]=0+0{,}0591\bullet\log(1\text{ M})=0\text{ Volts}.$$

In the reaction, **ne-** electrons are removed, so for electroneutrality, additional positively charged ions **Δn+** are moved towards the solution. Electrons remain in the metal electron gas. The movement of the **Δn+** charge in the system the products of the oxidized form $\underline{\mathbf{Ox}}^{\Delta n+}$ brings the negative charged electrons **ne-** part of the chemical potential $\mathbf{n\mu_{electr}=n\Delta G°e-=-nFE°}$, the free energy of which is proportional to the potential -0,27073 ~ **-26,121**

$$\Delta G°e-=\mathbf{-FE°}=-96485*-0{,}27073=\mathbf{-26{,}121}\ ^{kJ}/_{mol}.$$

Prigogine attractor $\mathbf{\Delta G_{eqH(Pt)}=-R\bullet T\bullet\ln(K_{eqH(Pt)})=E°nF}$ applies mathematics to the full extent of the Nernst electrochemical oxidation reaction $\underline{\mathbf{H}}\mathbf{(Pt)}+H_2O=H_3O^++\mathbf{e^-}$, listing four things in full composition:

1. Classical standard potential $E°_{Hclassic}$=0 Volts [1] of Nernst's classic electrochemistry reference zero 0 Volts;
2. the logarithm of water is listed $-0{,}0591*\log(1/[H_2O])=-0{,}0591*\log(1/55{,}3)=0{,}103$ V including the accounting of diluted hydroxonium ions. Hydrogen electrode in sulfuric acid $[H_2SO_4]=[H_3O^+]=1$ M solution with a density of 1,061 $^{g}/_{mL}$ and water concentration $[\mathbf{H_2O}]=963/18=52{,}5$ M. [11]
3. Classical hydrogen zero water, hydroxonium correction thermodynamic $E°_{HclassicH2Ocorrection}$=0,10166 Volts;
   $\mathbf{E}=E°_{HclassicThermodynamic}-0{,}591/1*\log([H_3O^+]/[H_2O])=0+0{,}0591*\log(1/52{,}5)=0{,}10166-0{,}10166=0$ V.
4. The absolute potential scale from classical 0.10166 V to sum absolute scale -0.27073-0.10166=-0.37239 V.

$$E°_{H\_OH}=E°_{Hclassic}-0{,}0591/1*\lg(1/[H_2O]^0)+0{,}10166-0{,}37239=0-0{,}0591/1*\log(1/55{,}3\text{^}0)+0{,}10166-0{,}37239=\mathbf{-0{,}27073}\text{ V};$$

The amount of water per liter of sulfuric acid $[H_2SO_4]=[H_3O^+]=1$ M solution concentrations is with a density of 1.061 g/mL Absolute hydroxonium ion, water calculation shows $E°_H$=-0.27073 V standard potential for metallic hydrogen. Hydrogen incorporated into the platinum crystal lattice is an active metal electrode with an inactive crystal lattice of platinum atoms.

The ratio $[H_3O^+]/[H_2O]=1\text{ M}/52.5\text{ M}=N_{H3O+}/N_{H2O}$ has mole fraction unitless instead moles per liter [H+]=1 M in the classical potential zero in the expression $\mathbf{E}=E°_{Hclassic}+0{,}0591/1\bullet\log([\mathbf{H^+}])=0+0{,}0591/1*\log(1)=0+0=0$ V. Mole fraction instead of the classical standard potential zero requires the classical thermodynamic standard potential $E°_{HclassicThermodynamic}$=0.10166 V, which is arbitrarily taken to be zero:

$$\mathbf{E}=E°_{HclassicThermodynamic}+\ln(10)\bullet R\bullet T/F/1\bullet\log(N_{H3O+}/N_{H2O})=0{,}10166+0{,}0591*\log(1/52{,}5)=0{,}10166-0{,}10166=0\text{ V}.$$

Absolute hydrogen electrode $\underline{\mathbf{H}}\mathbf{(Pt)}+\mathbf{H_2O}=\mathbf{H_3O^+}+\mathbf{e^-}$; potential

$$\mathbf{E}=E°_H+0{,}0591/n*\log(\mathbf{K_{H(Pt)}})=\mathbf{-0{,}27073}+0{,}0591/1*\log(1)=\mathbf{-0{,}27073\text{ V}}=E°_H$$

is the standard potential $\mathbf{E}=E°_H$ as the logarithm of the equilibrium constant one is zero

$$\log(\mathbf{K_{H(Pt)}})=\log([\mathbf{H_3O^+}]*[\mathbf{e^-}]/[\mathbf{H_2O}]/[\mathbf{H(Pt)}])=\log(1)=0\text{ Volts}.$$

Alberty data give exoergonical change $\mathbf{\Delta G_{eqH(Pt)}}=G_{H3O+}+G_{e-}-(\mathbf{G_{H(Pt)}}+\mathbf{G_{H2O}})=22{,}44+0-(\mathbf{48{,}56}+0)=\mathbf{-26{,}12}\ ^{kJ}/_{mol}$.
The change in free energy is determined on an absolute scale with reference to zero $\mathbf{G_{H2O}}=G_{CO2}^{gas}=G_{e-}=0\ ^{kJ}/_{mol}$.
The calculated hydrogen standard potential on an proportional scales of absolute free energy and potential is

$$E°_H=\mathbf{\Delta G_{eqH(Pt)}}/F/n=\mathbf{-26{,}12}*1000/96485/1=\mathbf{-0.27073\text{ V}}.$$

The equilibrium state minimum of free energy is exorgonic, spontaneous and negative

$$\mathbf{\Delta G_{eqH(Pt)}}=E°_H\bullet F\bullet n=\mathbf{-0.27073}*96485*1/1000=\mathbf{-26{,}12}\ ^{kJ}/_{mol},$$

in agreement with Alberty's data. The absolute potential scale is shifted down by

$$\Delta E=-0.27073-0{,}10166=-0{,}37239\text{ Volts}$$

lower relative to the classical thermodynamic scale of hydrogen standard electrode potential value +0.10166.
The Nernst equilibrium reaction is spontaneous, favorable, greater than one, for the oxidation of a metal to the hydroxonium ion $\mathbf{K_{H(Pt)}}=[H_3O^+]*[\mathbf{e^-}]/[\mathbf{H_2O}]/[\mathbf{H(Pt)}]=EXP(-\mathbf{\Delta G_{eqH(Pt)}}/R/T)=EXP(\mathbf{26120}/8{,}3144/298{,}15)=37675{,}6$.

Type I electrode metal H(Pt) / immersed in $\mathbf{H_3O^+}$ cation solution application.

The high-speed protolysis attractors $[H_3O^+]=10^{-7,36}$ M , pH=7.36 and water amount $[\mathbf{H_2O}]=997/18=55.3$ M, metallic hydrogen $[\mathbf{H}(Pt)]=1$ and free electrons $[\mathbf{e^-}]=1$ mol fraction per liter show a strong reducing potential

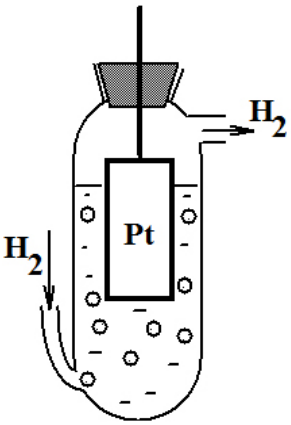
$\mathbf{E}_{pH=7,36}=E^\circ_H+0,0591*\log([\mathbf{H_3O^+}]*[\mathbf{e^-}]/[\mathbf{H_2O}]/[\mathbf{H}(Pt)])=-0.27073+0,0591*\log(10^{-7,36}*1/55,3/1)=-0,8087$ V

and a free energy change for the metal reductant in reaction is spontaneous, exoergonic, negative

$$\Delta\mathbf{G}_{pH\_7,36}=\mathbf{E}_{pH=7,36}\bullet F\bullet n=-0,8087*96485*1/1000=-78,03\ ^{kJ}/_{mol}\ .$$

Metal oxidation standard potential and Prigogine attractor energy change is exoergonic, negative

$E^\circ_H=-0.27073$ V and $\Delta\mathbf{G_{eq}}=\mathbf{-26.12}\ ^{kJ}/_{mol}$.



Platinum sheet immersed in hydroxonium ions $[H^+]=[H_3O^+]=[H_2SO_4]=1$ M sulfuric acid solutions $\underline{\mathbf{H}}(\mathbf{Pt})=\mathbf{H^+}+\mathbf{e^-}$: $\mathbf{E}=\mathbf{E}^\circ+0.0591\bullet\log[H^+]=\mathbf{0.0}+0.0591\bullet\log(1\ M)=\mathbf{0}$ V is classic. Ratio $[H_3O^+]/[\mathbf{H_2O}]=1/52.5=X_{\mathbf{H3O+}}/X_{\mathbf{H2O}}$ instead zero **0** classic give thermodynamic standard potential: $E^\circ_H=0.10166$ V and from Alberty data on absolute scale the absolute standard potential has $E^\circ_H=-0.27073$ Volts.

absolute $E^\circ_H=-0.27073$ V classic zero $E^\circ_H=0$ V 0.10166 V E,V

$$E_{(Pt)H/H^+}=E^\circ_H+0.0591*\log\left(\frac{X_{H_3O^+}}{X_{H_2O}}\right)\qquad E_{H\_classic}=E^\circ_H+0.0591*\log([H_3O^+])$$

thermodynamic E°_H

Absolute standard potential $E^\circ_H=-0.27073$ V based on Alberty data $G_{\mathbf{H2}}^{gas}=\mathbf{85.64}\ ^{kJ}/_{mol}$ and $G_{\mathbf{H2}aq}=\mathbf{103.24}\ ^{kJ}/_{mol}$ for hydrogen, which measured on water and carbon dioxide gas $G_{\mathbf{H2O}}=G_{\mathbf{CO2}}^{gas}=0\ ^{kJ}/_{mol}$ zero reference for absolute potential and absolute free energy scale.

Free energy content in one mol metal hydrogen $\underline{\mathbf{H}}(Pt)$ is $G_{\mathbf{H}(Pt)}=\mathbf{48.56}\ ^{kJ}/_{mol}$. (see above)

Substance	$\Delta H^\circ_H,\ ^{kJ}/_{mol}$	$\Delta S^\circ_H,\ ^{J}/_{mol/K}$	$\Delta G^\circ_H,\ ^{kJ}/_{mol}$
$\mathbf{H_2O}$	-285.85	69.9565	-237.191
$\mathbf{H_2O}$	**-286.65**	**-453.188**	**-151.549**
$\mathbf{H_3O^+}$	$G_{AlbertyH3O}=$	**22.44**	**-257.46**
$\mathbf{H_3O^+}$	-285,809	-182,5266	-231,3887
$\mathbf{H_3O^+}$ G_{e^-}	formation	-231,3887	**26,121**
$(Pt)\mathbf{H_{aq}}$	G_{e^-} format	-0,27073 V	**26,121**
$\mathbf{H}(Pt)$	$E^\circ_H=$	-0.27073	**48.56**
$\mathbf{H_2}^{gas}$	**-0.82**	**-289,9885**	**85.64**
$\mathbf{H_{2aq}}$	**-5.02**	**-363,106**	**103,24**
$\mathbf{O_2}_{aqua}$	**-11.70**	**-94.2**	**329.68**
$\mathbf{O_2}^{gas}$	formation	-237,191	**303,1**
OH^-	-230	-10,8	-157,2
OH^- G_{e^-}	formation	-157,2	**40,19**

$\Delta\mathbf{G}^\circ_{H2O}=G_{\mathbf{H2O}}-(G_{H2aq}+G_{\mathbf{O2}aq}/2)=\mathbf{0}-(\mathbf{103.24}+\mathbf{88.04}/2)=\mathbf{-147.26}\ ^{kJ}/_{mol}$;

$G_{H2O}=\Delta G_{\mathbf{H2O}Alberty}-(\Delta G^\circ_{H2O})=\mathbf{-151.549}-(-237.191)=\mathbf{85.6}\ ^{kJ}/_{mol}$ [8]

$\Delta G_H=\Delta H_H-T*\Delta S_H=\mathbf{-286.65}-298.15*\mathbf{-0.453188}=\mathbf{-151.5}\ ^{kJ}/_{mol}$;

$\Delta G^\circ_{H3O\_absolute}=G_{H3O}-(0.5G_{\mathbf{H2}}^{gas}+\mathbf{1.5}*G_{\mathbf{O2}}^{gas})=\mathbf{-257.46}\ ^{kJ}/_{mol}$;

$\Delta H^\circ_{\mathbf{H3O+}}=-285.809\ ^{kJ}/_{mol}$ Mischenko 1972, Himia, Leningrad [26]

$G_{e^-}=\Delta\mathbf{G}^\circ_{H3O+}-G_{H3O+}+(1,5*G_{H2}^{gas}+0,5*G_{\mathbf{O2}}^{gas})=\mathbf{26,121}\ ^{kJ}/_{mol}$;

$\Delta G^\circ e\text{-}=\mathbf{-FE}^\circ=-96485*-0,27073=\mathbf{26,121}\ ^{kJ}/_{mol}$;

$\Delta\mathbf{G}_{Hess\_eq}=G_{H3O+}-(G_{\mathbf{H}(Pt)}+G_{\mathbf{H2O}})=22.44-(\mathbf{48.56}+0)=\mathbf{-26.12}\ ^{kJ}/_{mol}$.

$\Delta G^\circ_{H2}{}^{gas}=\Delta H-T*\Delta S=\mathbf{-0,82}-298,15*\mathbf{-0,2899885}=\mathbf{85,64}\ ^{kJ}/_{mol}$; [8]

$\Delta G^\circ_{O2aq}=\Delta H-T*\Delta S=\mathbf{-5,02}-298,15*\mathbf{-0,363106}=\mathbf{103,24}\ ^{kJ}/_{mol}$; [8]

$G_{O2aq}=G_{O2}^{gas}+G_{\mathbf{O2}sp}=\mathbf{303.1}+26.58=\mathbf{329.68}\ ^{kJ}/_{mol}$ [8]

$G_{\mathbf{O2}}^{gas}=(G_{\mathbf{H2O}}-(G_{H2}^{gas}+\Delta\mathbf{G}^\circ_{H2O}))*2=\mathbf{0}-(\mathbf{85,64}-237,191))*2=\mathbf{303,1}\ ^{kJ}/_{mol}$;

CRC [1] $\Delta\mathbf{G}^\circ_{OH^-}=\Delta H-T*\Delta S=-230-298.15*-0.0108=-226.78\ ^{kJ}/_{mol}$;

$G_{e^-}=G_{\mathbf{OH^-}}-(G_{H2}^{gas}/2+G_{\mathbf{O2}aq}/2+\Delta\mathbf{G}^\circ_{OH^-})=\mathbf{40,19}\ ^{kJ}/_{mol}$;

$$\underline{\mathbf{H}}(Pt)\ +\ OH^-\ =\ H_2O\ +\ (Pt)\ +\ \mathbf{e^-}.$$

reduced form = oxidized form

The published hydrogen electrode standard potential $E_{o\_classic\ H\_OH-}=-0,8277$ V [1] is corrected by the absolute standard potential with absolute free energy data at pH=7,36 [8, 15]:

$G_{\mathbf{H2}}^{gas}=\mathbf{85,64}\ ^{kJ}/_{mol}$; $G_{\mathbf{H2}aq}=\mathbf{103,483}\ ^{kJ}/_{mol}$ 2006, Massachusetts Technology Inst. Alberty at pH=7,36 and $G_{OH^-}=\mathbf{77,36}\ ^{kJ}/_{mol}$; $G_{H(Pt)}\mathbf{48,56}\ ^{kJ}/_{mol}$; $G_{e^-}=\mathbf{26,121}\ ^{kJ}/_{mol}$; $G_{H2O}=\mathbf{0}\ ^{kJ}/_{mol}$;

The Prigogine attractor in the reaction is spontaneous, exoergonic, favored, because the change is negative:

$\Delta G_{AlbertyH\_OH-}=G_{H2O}+G_{e^-}-(G_{H(Pt)}+G_{OH^-})=\mathbf{0}+\mathbf{26,121}-(\mathbf{48,56}+\mathbf{77,36})=\mathbf{-99,799}\ ^{kJ}/_{mol}$.

In the reaction, **e-** electrons separated from positively charged protons $\mathbf{H^+}$ move towards the products for the balance of electroneutrality in the reaction. The **e-** electrons remain in the electron gas of the metal. The movement of the $\mathbf{H^+}$ charge in the system to the products in the oxidized form brings the electron **e-** part of the chemical potential $\mu_{\mathbf{electr}}=\Delta G^\circ e\text{-}=\mathbf{-FE}^\circ=\mathbf{26,121}\ ^{kJ}/_{mol}$, forming $\Delta G_{AlbertyH\_OH-}=G_{H2O}+\Delta G^\circ_{e^-}-(G_{H(Pt)}+G_{OH^-})=\mathbf{-99,799}\ ^{kJ}/_{mol}$ the Prigogine attractor of the reaction. The free energy change of $\mathbf{-99,799}\ ^{kJ}/_{mol}$ for the reaction is and shows the corresponding absolute standard potential as a Prigogine exoergonic attractor with a negative sign:

$$\Delta\mathbf{G}_{eq\mathbf{H}(Pt)}=\mathbf{-R\bullet T\bullet\ln}(\mathbf{K}_{eq\mathbf{H}(Pt)})=E^\circ_{OH}\bullet\mathbf{n}\bullet\mathbf{F}=\mathbf{-1,034347}*\mathbf{1}*96485=\mathbf{-99,799}\ ^{kJ}/_{mol}\ ;$$

The absolute standard potentialmE$^\circ_{OH}=\Delta\mathbf{G}_{eq}/F/1=\mathbf{-99799}/96485/1=\mathbf{-1,034347}$ V, using Prigogine attractor mathematics accounting four things in sum $E^\circ_{OH}=E_{o\_classic\ OH-}-0,0591/1*\log([H_2O])+0,10166-0,37239=$

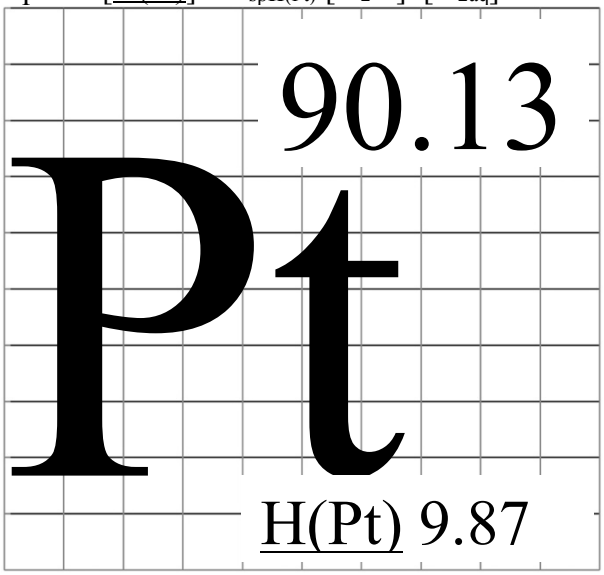
$=-0,65988-0,0591/1*\log(56,9227)+0,10166-0,37239=\mathbf{-1,034347}$ V is exoergonic, negative

The published potential $E_{o\_classic\ OH-}=-0,8277$ V at pH>8 [1] is replaced by the corrected standard potential $E_{o\_classic\ OH-}=-0,65988$ V based on the absolute potential. Calculated on the absolute energy, potential scale and water concentration $[H_2O]=56,9227$ M, **NaOH** 0,104 M in a 4% solution with density 1040 g/L.

Solubility $\mathbf{H_2}^{gas}+H_2O=\mathbf{H}_{2aq}$ molar $Xi*[\mathbf{H_2O}]=[\mathbf{H}_{2aq}]=0.00001411*55.3=0.00078028$ M in mole fractions is $Xi=[\mathbf{H}_{2aq}]/[\mathbf{H_2O}]=0.00001411$. [1] $[\mathbf{H}_{2aq}]=K_{sp}*[\mathbf{H_2O}]=0.00082526*55.3=0.04564$ M, if pure gas $\mathbf{H_2}^{gas}$ mol fraction is 1, than free energy $\Delta\mathbf{G}_{sp\_H2}=G_{\mathbf{H2}aq}-(G_{\mathbf{H2}}^{gas}+G_{H2O})=\mathbf{103.24}-(\mathbf{85.64}+0)=\mathbf{17.6}$ $^{kJ}/_{mol}$ accumulates in to $G_{\mathbf{H2}aq}=\mathbf{103.24}$ $^{kJ}/_{mol}$. Prigogine attractor $\Delta\mathbf{G}_{sp\_\mathbf{H2}}=-RTln(\mathbf{K}_{sp\_\mathbf{H2}})=\mathbf{17.6}$ $^{kJ}/_{mol}$ shows solubility more by Alberty Biochemistry [8] data $[\mathbf{H}_{2aq}]=0.04564$ M as by CRC [1] data $[\mathbf{H}_{2aq}]=0.00078028$ M with equilibrium constant:

$$\mathbf{K}_{sp\_\mathbf{H2}}=[\mathbf{H}_{2aq}]/[\mathbf{H_2}^{gas}]/[\mathbf{H_2O}]=EXP(-\Delta\mathbf{G}_{sp\_\mathbf{H2}}/R/T)=EXP(-\mathbf{17600}/8.3144/298.15)=0.00082526.$$

Nernst's hydrogen oxidation to hydroxonium $\mathbf{H}_{2aq}+2H_2O=2\mathbf{H_3O}^{+}+2e^{-}$ consume two water molecules. Oxidation is spontaneous, $\Delta\mathbf{G}_{Hess\_H3O+}=2G_{H3O+}+2G_{\underline{e}^-}-(G_{\mathbf{H2}aq}+2G_{H2O})=2*22.44+2*0-(\mathbf{103.24}+0)=-58.36$ $^{kJ}/_{mol}$, as is negative, exoergonic. A graphite electrode oxidizes a solution of $\mathbf{H}_{2aq}$ to hydroxonium at the absolute standard potential: $\mathbf{H}_{2aq}+2H_2O=2\mathbf{H_3O}^{+}+2e^{-}$; $E^{\circ}_{H2aq}=-58.36*1000/96485/2=-0.30243$ V and reduction on incorporate metal hydrogen in platinum electrode $2\mathbf{H_3O}^{+}+\underline{(Pt)}+2e^{-}=2\underline{\mathbf{H}(Pt)}+2H_2O$ $-E^{\circ}_{H(Pt)}=+0.27073$ V. Change $\mathbf{H}_{2aq}+\underline{(Pt)}=2\underline{\mathbf{H}(Pt)}+H_2O$ is $(E^{\circ}_{H2aq}-E^{\circ}_{H(Pt)})=(-0.302+0.27073)=-0.03128$ V of free energy is negative $\Delta\mathbf{G}_{sp\mathbf{H}(Pt)}=\Delta E^{\circ}_{sp\mathbf{H}(Pt)}\bullet F\bullet 2=(E^{\circ}_{H2aq}-E^{\circ}_{H(Pt)})\bullet F\bullet 2=(-0.302+0.27073)*96485*2=-0.03128*96485*2=\mathbf{-6.117}$ $^{kJ}/_{mol}$. Hess law overall reaction $\mathbf{H}_{2aq}+\underline{(Pt)}=2\underline{\mathbf{H}(Pt)}+H_2O$ solubility product of hydrogen in the metal shows exoergonic $\Delta\mathbf{G}_{sp\_\mathbf{H}(Pt)}=2G_{\mathbf{H}(Pt)}+G_{H2O}-(G_{\mathbf{H2}aq})=2*\mathbf{48.56}+0-(\mathbf{103.24})=\mathbf{-6.12}$ $^{kJ}/_{mol}$ constant, greater as one at equilibrium state standard $\mathbf{K}_{sp\_\mathbf{H}(Pt)}=[\underline{\mathbf{H}(Pt)}]^2*[\mathbf{H_2O}]/[\mathbf{H}_{2aq}]=EXP(-\Delta\mathbf{G}_{sp\mathbf{H}(Pt)}/R/T)=EXP(\mathbf{6120}/8.3144/298.15)=11.808$. From the ratio $[\underline{\mathbf{H}(Pt)}]^2/[\mathbf{H}_{2aq}]=\mathbf{K}_{sp\_\mathbf{H}(Pt)}/[\mathbf{H_2O}]=11.808/55.3=0.213526$ obtains mol fraction of **H**(Pt) hydrogen square: $[\underline{\mathbf{H}(Pt)}]^2=K_{sp\mathbf{H}(Pt)}/[\mathbf{H_2O}]*[\mathbf{H}_{2aq}]=11.808/55.3$ M$*0.04564$ M$=0.009745$. Saturated solubility in mol fraction of platinum lattice is square root of square $[\underline{\mathbf{H}(Pt)}]=SQRT([\underline{\mathbf{H}(Pt)}]^2)=SQRT(0.009745)=0.0987$ in mol fraction units is hydrogen atom surface fraction 9.87% shared with platinum atoms fraction 90.13% on total 100% platinum lattice surface. $\mathbf{H}_{2aqAlbery}=2\underline{\mathbf{H}(Pt)}+\mathbf{H_2O}$ Solubility mol fractions concentrations are unit less as constant too $\mathbf{K}_{sp\_\mathbf{H}(Pt)}=11.808$.



$\underline{\mathbf{H}(Pt)}$ solubility in water $2\underline{\mathbf{H}(Pt)}+\mathbf{H_2O}=\mathbf{H}_{2aqAlberty}$ constant is less as one $\mathbf{K}_{sp\mathbf{H}(Pt)\_H2aq}=1/K_{sp\mathbf{H}(Pt)}=1/11.808=0.08469$

$$\mathbf{K}_{sp\mathbf{H}(Pt)\_H2aq}=[\mathbf{H}_{2aq}]/[\underline{\mathbf{H}(Pt)}]^2/[\mathbf{H_2O}]=0.08469.$$

and $\Delta\mathbf{G}_{Alberty}=G_{\mathbf{H2}aq}-2G_{\mathbf{H}(Pt)}-G_{\mathbf{H2O}}=\mathbf{6.12}$ $^{kJ}/_{mol}$ positive, unfavored, non-spontaneous. It keeps metal lattice saturated with hydrogen 9.87%, because attractor **6.12** $^{kJ}/_{mol}$ is positive and constant less as one 0.08469 so is unfavored for hydrogen dissolution from crystal lattice of platinum $\mathbf{K}_{sp\mathbf{H}(Pt)\_H2aq}=EXP(-\Delta\mathbf{G}_{sp\_\mathbf{H}(Pt)}/R/T)=0.08469$.

Scheme 1. Platinum corpus total surface of just immersed electrode part into water solution is 100%. The spontaneous diffusion of hydrogen dissolved from an aqueous solution into the platinum Pt metallic lattice creates an active hydrogen metal contact surface area of 9.87%. The inactive platinum surface area is 90.13%.

One hundred percent of the entire hydrogen surface area (9.87%) and the total free electron pool of the Pt+H(Pt) metallic electrode are involved in the electrochemical reaction.

As a result of the spontaneous oxidation of hydrogen, electrons accumulate in the gas. So forming an excess of electrons, which cathodic negatively charges the electrode potential, lowering it $E_H<0$.

On the metal surface, when reducing the protons of the hydroxonium $\mathbf{H_3O}^{+}$ solution, the metal loses electrons. So anodic positively charging the electrode potential, increasing it $EH>0$.

Hydrogen metal is a strong reducing agent, so the standard potential is negative $E^{\circ}_H=-0.27073$ V.

In a biochemical environment, the attractor pH=7.36 and water concentration $[\mathbf{H_2O}]=55,3$ mol/L reduces the potential three times from $E^{\circ}_H=-0.27073$ V to $\mathbf{E}_{pH=7,36}=-0,8087$ V

$\mathbf{E}_{pH=7,36}=E^{\circ}_H+0,0591*\log([\mathbf{H_3O}^{+}]*[\mathbf{e}^{-}]/[\mathbf{H_2O}]/[\mathbf{H(Pt)}])=-0.27073+0,0591*\log(10^{-7,36}*1/55,3/1)=-0,8087$ V, because the concentration of pure substances on the metal surface is one $[\mathbf{e}^{-}]=1$ un $[\mathbf{H(Pt)}]=1$.

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