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# The discovery of Hydrogen electrode reference point $E^{\circ}_{H}$= -0.2965 Volts in **absolute potential scale** synchronizes the sciences with **absolute** free energy scale**.**

My talk today focuses on research on the **absolute** scaling of energy and potential, which is the same number with the opposite sign in the **inverse** symmetry of the reactions.

I am really happy to joining you for the 10th INTERNATIONAL CONFERENCE on new trends in CHEMISTRY at Topic:

The discovery of Hydrogen electrode reference point $E^{\circ}_{H}$= -0.2965 Volts
in **absolute potential scale** synchronizes the sciences with **absolute** free energy scale**.**

The discovery of Hydrogen electrode reference point $E^{\circ}_{H}$=-0.2965 V for the **absolute** potential and **absolute** free energy scale in a half-reaction determines the property of **inverted** symmetry: The inverted reaction potential belongs to the same number with the opposite sign.

Symmetry coincides with the **inverted absolute** free energy, whose number is the same but with the opposite sign

**Absolute** and **inverse** free energy and potential **scale** requires water and hydroxonium accounting based on Alberty data of hydrogen gas and solution **absolute** free energy values.

Nernst classic half-reaction with discounting water and hydroxonium is $\mathbf{H(Pt)=H^{+}+e^{-}}$.

Standard classic potential zero $\mathbf{E^{\circ}_{H}=0.0}$ V is taken in $[H^{+}]$=1 M sulfuric acid solution measured potential: [11]

$$\mathbf{E}=\mathbf{E}^{\circ}_{H}+0.0591\bullet\log[H^{+}]=\mathbf{0.0}+0.0591\bullet\log(1\text{ M})=\mathbf{0}\text{ V}$$

and is the zero reference to the classic potential scale since 1920th Nobel Prise in Chemistry.

The thermodynamic half-reaction with accounting for water and hydroxonium is $\mathbf{H(Pt)+H_2O=H_3O^{+}+e^{-}}$.

Thermodynamic Potential expression for half reaction on taken zero potential **E**=**0** V of value is:

$$\mathbf{E}=\mathbf{E}^{\circ}_{H}+0.0591\bullet\log([\mathbf{H_3O^{+}}]/[\mathbf{H_2O}])=0.10166+0.0591\bullet\log(1\text{ M}/52.5\text{ M})=\mathbf{0}\text{ V}$$

where 0.0591*log(1/52.5)=**-0.10166** V is thermodynamic standard potential correction.

Water accounting corrects thermodynamic standard potential: $E^{\circ}_{H}$= 0.10166 V on thermodynamic potential scale instead zero: $\mathbf{E}=\mathbf{E}^{\circ}_{H}+\frac{\ln(10)*\mathbf{R}*\mathbf{T}}{\mathbf{F}*1\mathbf{e}^{-}}\bullet\log\frac{[H_3O^{+}]}{[H_2O]}$ =0 V; $\mathbf{E^{\circ}_{H}}$=**E**-0.0591*log(1/52.5)=0-(**-0.10166**)=0.10166 V.

Ratio $[\mathbf{H_3O^{+}}]/[\mathbf{H_2O}]$=1/52.5 give corrected thermodynamic standard potential $E^{\circ}_{H}$= 0.10166 V instead classic zero.

In Nernst's half reaction for hydrogen $\mathbf{H(Pt)+H_2O=H_3O^{+}+e^{-}}$ point of standard the **Absolute Potential** is

$$\mathbf{E^{\circ}_{H}}=-0.29654\text{ V}.$$

Nernst half-reaction on the **Absolute** standard **Potential** value produced change in the potential free energy scale:

$$\Delta\mathbf{G_{eq}}=\mathbf{E^{\circ}_{H}}\bullet F\bullet 1\bullet 1=-0.29654*96485*1=\mathbf{-28.61}\ ^{kJ}/_{mol}$$

is identical in Hess law calculated free energy change as exoergic on **Absolute** scale referring relative to water zero free energy content $G_{\mathbf{H2O}}$=0 $^{kJ}/_{mol}$ :

$$\Delta\mathbf{G}_{\text{Hess\_}\mathbf{eq}}=G_{H3O+}+G_{e-}-(G_{\mathbf{H(Pt)}}+G_{\mathbf{H2O}})=22.44+0-(\mathbf{51.05}+0)=\mathbf{-28.61}\ ^{kJ}/_{mol}.$$

The **Absolute** standard **potential** $\mathbf{E^{\circ}_{H}}$= -0.29654 Volts is coinciding with **Absolute** free energy scale of Alberty data. [8,15]

## Absolute OxRed potential scale shifts about ΔE=-0.29654-0.10166=-0.3982 Volts down.

**Water account** in **sciences** requires **absolute free energy scale** which synchronizes the **absolute potential scale** of **Nernst's reactions** into **inverse symmetry identical values** but with **opposite sign.**

Attractor pH=7.36 staying at equilibrium have true pOH=6.64 value as $pK_w$=14= pH+pOH =7.36 +6.64**.**
Disaccount the water mass [$\mathbf{H_2O}$]=963/18=53.5 M over liter [$H_2SO_4$]=[$H_3O^+$]=1 M solution with 1.061 $^{g}/_{mL}$ density in Nernst equations for **hydrogen electrode** has classic standard potential $E_{o\_classic}$=0 V reference zero:
**H(Pt)=H⁺+e⁻**; **E**$_{classic}$=$E_{o\_classic}$+0.0591•log**K°**$_{classic\mathbf{H}(Pt)}$=0+0.0591•log[$H^+$]=0+0.0591•log(1 M)=0 Volts. [11]
Thermodynamic account Hydroxonium ions demand the water: **H(Pt)+$\mathbf{H_2O}$<=>$\mathbf{H_3O^+}$+e⁻** and $E^\circ_H$=0.10166 V.
The ratio [$\mathbf{H_3O^+}$]/[$\mathbf{H_2O}$]=1 M/52.5 M=$X_{H_3O^+}/X_{H_2O}$ is mol fraction instead molarity [**H⁺**]=1 M at classic potential expression. The water account gave thermodynamic standard $E^\circ_H$=0.10166 V on potential scale.
Nernst's expression with classic zero measurement require thermodynamic standard potential $E^\circ_H$=0.10166 V :

$$\mathbf{E}=E^\circ_H+\frac{\ln(10)\bullet R\bullet T}{F\bullet 1}\bullet\log\frac{X_{H_3O^+}}{X_{H_2O}}=E_o+E^\circ_H+0.0591*\log(1/52.5)=0.10166-0.10166=0\ \text{V.}$$

As ratio **1=K**$_{\mathbf{H}(Pt)}$=$X_{H_3O^+}/X_{H_2O}$ is one than $E^\circ_H$=0.10166 V is thermodynamic standard potential:

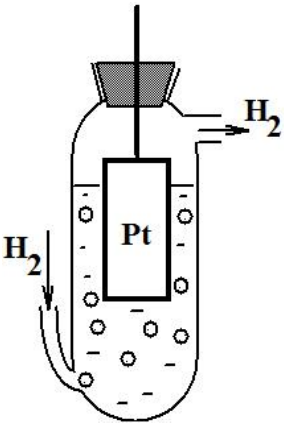
$$\mathbf{E}=E^\circ_H+\frac{\ln(10)\bullet R\bullet T}{F\bullet 1}\bullet\log\frac{X_{H_3O^+}}{X_{H_2O}}=0.10166+0.0591*\log(1)=0.10166\ \text{V.}$$

Metal oxidation free energy change minimum is different endoergic Δ**G**$_{\mathbf{eq}}$=$E^\circ_H$•F•1•1=0.10166*96485*1=9.81 $^{kJ}/_{mol}$ instead Alberty is exoergic .
Alberty data Hess value is exoergic; Δ**G**$_{Hess\_\mathbf{eq}}$=$G_{H_3O^+}$+$G_{e^-}$-($G_{\mathbf{H}(Pt)}$ +$G_{\mathbf{H_2O}}$)=22.44+0-(**51.05**+0)=**-28.61** $^{kJ}/_{mol}$ .
Free energy changes are determined on water and carbon dioxide gas zero $G_{\mathbf{H_2O}}$=$G_{\mathbf{CO_2}gas}$=$G_{e^-}$=0 $^{kJ}/_{mol}$ reference scale. Iterative found on absolute scale hydrogen standard potential is: $E^\circ_H$= -0.29654 V. Equilibrium free energy minimum is exoergic: Δ**G**$_{\mathbf{eq}}$=$E^\circ_H$•F•n=-0.29654*96485*1=**-28.61** $^{kJ}/_{mol}$ coinciding with Alberty data. Absolute potential scale slips by ΔE=-0.29654-0.10166=-0.3982 Volts down. Nernst's hydrogen equilibrium constant is grater as one: **K**$_{\mathbf{H}(Pt)\_Red}$=[$H_3O^+$]*[**e⁻**]/[$\mathbf{H_2O}$]/[H(Pt)]=EXP(-Δ**G**$_{Alberty}$/R/T)=EXP(**28612**/8.3144/298.15)=102954 .

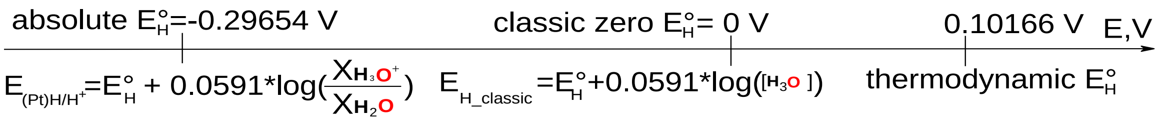
I type electrode Metal interface **H(Pt)** / on its cation $H_3O^+$ solution application.

High rate protolysis attractors [$H_3O^+$]=$10^{-7.36}$ M , pH=7.36 and water mass [$\mathbf{H_2O}$]=997/18=55.3 M account in liter shows metal hydrogen strong reducing potential: **E**$_{pH=7.36}$=-0.29654+0.0591*log($10^{-7.36}$/55.3)= -0.8345 V and free energy change minimum Δ**G**$_{\mathbf{eq}pH\_7.36}$=$E^\circ_H$•F•1=-0.8345*96485*1/1000=-80.5 $^{kJ}/_{mol}$ .

Nernst's half reaction reduction equilibrium potential $E^\circ_H$=-0.29654 V energy change is Δ**G**$_{\mathbf{eq}}$=**-28.6** $^{kJ}/_{mol}$.



Platinum sheet immersed in hydroxonium ions [$H^+$]=[$H_3O^+$]=[$H_2SO_4$]=1 M acid solution **H(Pt)<=>H⁺+e⁻**: **E=E°**+0.0591•log[$H^+$]=**0.0**+0.0591•log(1 M)=**0** V is classic. [11] Ratio [$\mathbf{H_3O^+}$]/[$\mathbf{H_2O}$]=1/52.5=$X_{H_3O^+}/X_{H_2O}$ give thermodynamic standard potential: $E^\circ_H$=0.10166 V instead classic zero **0** . Absolute standard potential $E^\circ_H$=-0.29654 V based on Alberty hydrogen data $G_{\mathbf{H_2}gas}$=**85.6** $^{kJ}/_{mol}$ and $G_{\mathbf{H_2}aq}$=**103** $^{kJ}/_{mol}$, whose **Absolute** free energy is referred to the background zero value of water and carbon dioxide $G_{\mathbf{H_2O}}$=$G_{\mathbf{CO_2}gas}$=0 $^{kJ}/_{mol}$.



Reducing agent at pH=7.36 , [$H_3O^+$]=$10^{-7.36}$ M with potential **E**=-0.2965+0.0591*log(10^(-7.36)/55.3)=-0.8345 V is strong reductant. Free energy content one mol metal hydrogen has: $G_{\mathbf{H}(Pt)}$=**51.05** $^{kJ}/_{mol}$ .

**Inverse** half reaction in acidic medium produces water: $O_{2aqua}+4H_3O^++4e^-<=>6H_2O$ . Hess value is exoergic: $\Delta G_{eq2H2O}=6G_{H2O}-(G_{O2aqua}+4G_{H3O+})=6*0-(\mathbf{330+4*22.44})=\mathbf{-419.76}\ {}^{kJ}/_{mol}$ as **inverse absolute** standard potential $-E^\circ_{O2}=\mathbf{-1.0868}$ V. Free energy change is negative $\Delta \mathbf{G}_{eq}=-E^\circ_{O2}\cdot F\cdot 1\cdot 4=\mathbf{-1.0868}*96485*4=\mathbf{-419.44}\ {}^{kJ}/_{mol}$ and coinciding with Alberty data on exoergic Hess value for half reaction.

Four reducing half reactions: $\underline{4\mathbf{H}(Pt)}+4H_2O=4H_3O^++4e^-$; $E^\circ_H=\mathbf{-0.2965}$ V give free energy change minimum $\Delta \mathbf{G}_{eq}=(E^\circ_H-E^\circ_{O2})\cdot F\cdot 1\cdot 4=(\mathbf{-0.2965-1.0868})*96485*4=-1.38334*96485*4/1000=-533.9=2*\mathbf{-266.94}\ {}^{kJ}/_{mol}$ for water production $O_{2aqua}+4\underline{\mathbf{H}(Pt)}=2H_2O$ from elements with energy contents $\mathbf{G}_{H(Pt)}=\mathbf{51}\ {}^{kJ}/_{mol}$ and $G_{O2aq}=\mathbf{330}\ {}^{kJ}/_{mol}$:

Oxidation reaction of hydrogen in water $O_{2aqua}+\underline{2}H_{2aqua}=2H_2O$ is producing Hess free energy change too the same $\Delta G_{HessH2Oaqua}=(2G_{H2O}-(2G_{H2aqua}+G_{O2aqua}))/2=(0-(2*\mathbf{103}+\mathbf{330}))/2=\mathbf{-268}\ {}^{kJ}/_{mol}$ coincident with **absolute** potential energy scale $\Delta \mathbf{E}_{eqH2O}=(E^\circ_H-E^\circ_{O2})/2=(\mathbf{-0.2965-1.0868})/2$ for $\Delta \mathbf{G}_{eqH2O}=-266.94\ {}^{kJ}/_{mol}$.

From Hess equation $\Delta G_{eq2H2O}=2G_{H2O}-4G_{H(Pt)}-G_{O2aqua}=2*0-(4*G_{H(Pt)}+\mathbf{330})=-533.9=2*\mathbf{-267}\ {}^{kJ}/_{mol}$ is obtainable metal **absolute** free energy content $G_{H(Pt)}=(2G_{H2O}-\Delta \mathbf{G}_{eq2H2O}-G_{O2aqua})/4=(2*0+533.886-\mathbf{330})/4=\mathbf{51.05}\ {}^{kJ}/_{mol}$ . **Absolute** free energy contents are calculated for water and gas $\mathbf{CO_{2gas}}$ scaled to zero $G_{H2O}=G_{CO2gas}=0\ {}^{kJ}/_{mol}$ . Hydrogen metal is incorporated platinum lattice with $G_{H(Pt)}=\mathbf{51}\ {}^{kJ}/_{mol}$ , element nitrogen has $G_{N2gas}=\mathbf{-15.26}\ {}^{kJ}/_{mol}$, for oxygen gas $G_{O2gas}=\mathbf{303}\ {}^{kJ}/_{mol}$ , plus $G_{O2sp}=26.58\ {}^{kJ}/_{mol}$ solubility oxygen in water $G_{O2aqua}=\mathbf{330}\ {}^{kJ}/_{mol}$, for graphite in reaction with oxygen gas and hydrogen gas $G_{graphite}=G_{CO2gr}=G_{CgrCH4gas}=\mathbf{91.26}\ {}^{kJ}/_{mol}$ .

Solubility $\mathbf{O_{2gas\ AIR}}+\mathbf{H_2O}\overset{\underline{Aquaporins}}{==>}\mathbf{O_{2aq}}$ to products energy increases about $G_{O2sp}=26.58\ {}^{kJ}/_{mol}$:

$[\mathbf{O_{2aq}}]/[\mathbf{O_{2gas\ AIR}}]/[\mathbf{H_2O}]=K_{sp}=2.205*10^{-5}$. $G_{O2sp}=\mathbf{-R\cdot T\cdot \ln(K_{sp})}=-8.3144*298.15*\ln(2.205*10^{-5})=26.58\ {}^{kJ}/_{mol}$.

Data from CRC gas $O_{2gas}+\underline{2}H_{2gas}=>2H_2O$ to one mol content of water show $\Delta G_{HessH2O}=-237.19\ {}^{kJ}/_{mol}$.

One mol oxygen contains $G_{O2gas}=2*G_{H2O}-2*(\Delta G_{HessH2O}+G_{H2gas})=2*0-2*(-237.19+\mathbf{85.64})=\mathbf{303}\ {}^{kJ}/_{mol}$ forming from gas elements $\Delta G_{HessH2OBioChem}=(2G_{H2O}-(2G_{H2gas}+G_{O2gas}))/2=(0-(2*\mathbf{85.64}+\mathbf{303}))/2=-237.19\ {}^{kJ}/_{mol}$ . [1,8]

CRC [1] $\Delta G_{HessH2O}=-237.19\ {}^{kJ}/_{mol}=(2G_{H2O}-(2G_{H2gas}+G_{O2gas}))/2=-237.19\ {}^{kJ}/_{mol}=\Delta G_{HessH2OBioChem}$. Alberty [8] Data from [1] and [8] are coinciding $-237.19\ {}^{kJ}/_{mol}=-237.19\ {}^{kJ}/_{mol}$ . **Absolute** energy in aqua solutions are $G_{H2aqua}=\mathbf{103}\ {}^{kJ}/_{mol}$ and $G_{O2aqua}=G_{O2gas}+G_{O2sp}=\mathbf{303}+26.58=\mathbf{330}\ {}^{kJ}/_{mol}$ too exoergic $O_{2aqua}+\underline{2}H_{2aqua}=>2H_2O$:

$G_{HessH2OBioChem}==(2G_{H2O}-(2G_{H2aqua}+G_{O2aqua}))/2=(2*0-(2*\mathbf{103}+\mathbf{330}))/2=\mathbf{-268}\ {}^{kJ}/_{mol}$ .

Alberty data on hydrogen gas $G_{H2gas}=\mathbf{85.64}\ {}^{kJ}/_{mol}$ , on hydrogen in water $G_{H2aqua}=\mathbf{103}\ {}^{kJ}/_{mol}$ are used for solubility products like reaction in water: $\mathbf{H_{2gas}}+\mathbf{H_2O}=\mathbf{H_{2aq}}$. Hydrogen solubility absolute energy change is:

$$\Delta G_{H2spAlberty}=G_{H2aq}-G_{H2gas}-G_{H2O}=\mathbf{103.24-85.64-0=17.6}\ {}^{kJ}/_{mol}\ .$$

**Alberty** biochemistry mathematic application data are forming solubility product on mol fraction units $K_{H2sp}$ $[\mathbf{H_{2aq}}]/[\mathbf{H_{2gas}}]/[\mathbf{H_2O}]=K_{H2sp}=EXP(-\Delta \mathbf{G}_{H2spAlberty}/R/T)=EXP(\mathbf{-17600}/8.3144/298.15)=0.0008253$ with solubility $[\mathbf{H_{2aq}}]=K_{H2sp}*[\mathbf{H_2O}]=0.0008253*55.3=0.04564$ M, if pure gas mol fraction is one $[\mathbf{H_{2gas}}]=1$. [8]

$\mathbf{H_{2gas}}+\mathbf{H_2O}=>\mathbf{H_{2aqCRC}}$ ; Solubility in 100 grams distilled water 0.000155 ${}^{g}/_{100g\_H2O}$, density 0.996 g/L forming concentration $[\mathbf{H_{2aqCRC}}]=0.000155/2/100.000155*996=0.0007719$ M **,** [1] CRC

Solubility product $K_{spCRC}=[\mathbf{H_{2aq}}]/[\mathbf{H_2O}]=0.0007719/55.3=0.000013958$ and **absolute** free energy change is

$$\Delta G_{spH2CRC}=-R\cdot T\cdot \ln(K_{spH2CRC})=-8.3144*298.15*\ln(0.000013958)=27.7\ {}^{kJ}/_{mol}.$$

Biochemistry water favored solubility $G_{H2spAlberty}=G_{H2aq}-G_{H2gas}-\Delta G_{H2O\_Biochemistry}=\mathbf{103.24-85.64-85.6=-68}\ {}^{kJ}/_{mol}$ : $[\mathbf{H_{2aq}}]/[\mathbf{H_{2gas}}]/[\mathbf{H_2O}]=K_{H2sp\_Biochemistry}=EXP(-\Delta \mathbf{G}_{H2spAlberty}/R/T)=EXP(\mathbf{68000}/8.3144/298.15)=10\wedge^{11.9}$ with concentration $[\mathbf{H_{2aq}}]=K_{H2sp\_Biochemistry}*[\mathbf{H_2O}]=10\wedge^{11.9}*55.3=10\wedge^{13.6}$ M, if hydrogen $\mathbf{H_{2gas}}$ pure gas mol fraction is one $[\mathbf{H_{2gas}}]=1$. [8]

Nernst's $H_{2aq}+2H_2O=2H_3O^++2e^-$ hydrogen oxidation to hydroxonium is spontaneous, because **absolute** free energy change is positive. $\Delta G_{Hess\_H3O+}=G_{H2aq}+2G_{H2O}-(2G_{H3O+}+2G_{e-})=2*22.44+2*0-(\mathbf{103.24}+2*0)=-58.36\ ^{kJ}/_{mol}$.
With graphite oxidizes $H_{2aq}$ solution to hydroxonium with standard **absolute** standard potential

$$E^\circ_{H3O+}=-58.36*1000/96485/2=-0.302\ V.$$

$\underline{H(Pt)}$ half reaction **inverse** standard potential $-E^\circ_{H(Pt)}=+\mathbf{0.2965}$ V and Nernst's hydrogen solution oxidation half reaction summary $E^\circ_{H3O+}=-0.302$ V $H_{2aq}+2H_2O=2H_3O^++2e^-$; $2H_3O^++2e^-=\underline{H(Pt)}+2H_2O$; $-E^\circ_{H(Pt)}=+\mathbf{0.2965}$ V shows hydrogen mol fraction $[H_{2aqAlberty}]$ solubility in to metal exoergic spontaneous:

$H_{2aqAlberty}=2\underline{H(Pt)}$ ; $K_{Alberty\_spH(Pt)}=[\underline{H(Pt)}]^2/[H_{2aqAlbery}]$ on mol fraction units less concentration;

$$\Delta G_{electro\_spH(Pt)}=\Delta E^\circ_{sp\_H(Pt)}\bullet F\bullet 2=(E^\circ_{H3O+}-E^\circ_{H(Pt)})\bullet F\bullet 2=(-0.302+\mathbf{0.2965})*96485*2=-0.0055*96485*2=-\mathbf{1.06}\ ^{kJ}/_{mol};$$

$K_{Alberty\_spH(Pt)}=[\underline{H(Pt)}]^2/[H_{2aqAlbery}]=EXP(-\Delta G_{Alberty}/R/T)=EXP(\mathbf{1060}/8.3144/298.15)=1{,}5336$ . [8]

In solubility product reaction $H_{2aqAlberty}=2\underline{H(Pt)}+H_2O$ ; $K_{Alberty\_sp\_H(Pt)}=[\underline{H(Pt)}]^2*[H_2O]/[H_{2aqAlbery}]$ shows hydrogen mol fraction units less $[H_{2aqAlberty}]/[H_2O]$ solubility product in to metal exoergic:

$$\Delta G_{Alberty\_sp\_H(Pt)}=2G_{H(Pt)}+G_{H2O}-(G_{H2aq})=2*\mathbf{51.05}+\mathbf{0}-(\mathbf{103.24})=-\mathbf{1.14}\ ^{kJ}/_{mol}\ .$$

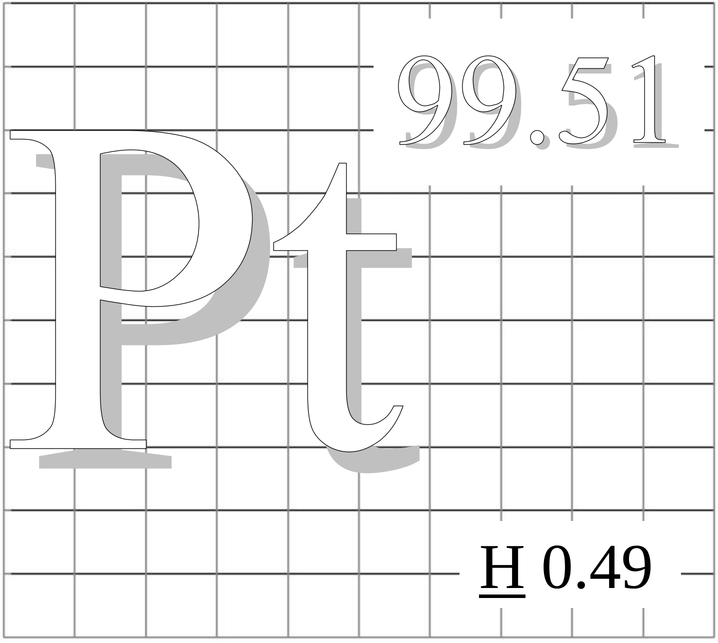
$K_{Alberty\_sp\_H(Pt)}=[\underline{H(Pt)}]^2*[H_2O]/[H_{2aqAlbery}]=EXP(-\Delta G_{Alberty}/R/T)=EXP(\mathbf{1140}/8.3144/298.15)=1{,}584$ . [8]

$[\underline{H(Pt)}]^2/[H_{2aqAlbery}]=K_{Alberty\_sp\_H(Pt)}/[H_2O]=1{,}58387/55.3=0{,}02864$ M if $[H_{2aqAlbery}]=0.0008253$ mol fraction is at saturation. Solubility square area of mol fraction is:

$$[\underline{H(Pt)}]^2=K_{spH(Pt)}/[H_2O]*[H_{2aqAlbery}]=1.584/55.3*0{,}0008253=0{,}00002364.$$

Solubility of mol fraction $[\underline{H(Pt)}]=SQRT(1{,}584/55{,}3*0{,}0008253)=0{,}004862$ is hydrogen atom surface fraction 0,486% shared with platinum atoms fraction 99,514% on total 100% platinum lattice surface. Hydrogen saturated metal mol fraction and percents of $\underline{H(Pt)}$ are

$[\underline{H(Pt)}]=SQRT(0{,}00002364)=0{,}00486$ and w%=**0,49**% les as one if pure gas mol fraction is one $[H_{2gas}]=1$.



Solubility of mol fraction is hydrogen surface fraction 0,49%, which has shared with platinum atoms fraction 99,51% on total surface 100% area of platinum crystal lattice. One square 1□ is one percent 1% of surface and 100 squares are 100% as 10*10=100□. Solubility $H_{2aqAlberty}=2\underline{H(Pt)}+H_2O$ concentrations mol fractions are unit less as constant too: $K_{Alberty\_sp\_H(Pt)}=1{,}584$.

Atom radiuses are Pt 0.135 nm and H 0,053 nm. Atom square area on surface are Pt 0.0729 nm$^2$ , H 0.0112 nm$^2$. Two atoms 0.0729+0.0112=0.0841 nm$^2$ are shared surface total area 100% progress for Platinum atom has 0.0729/0.0841=86.7% and 0.0112/0.0841=9,53% own H hydrogen atom. [25]

$\underline{H(Pt)}$ solubility in water is less as one $K_{sp\_H(Pt)}=0.631$:

$$2\underline{H(Pt)}+H_2O=H_{2aqAlberty};\ K_{sp\_H(Pt)}=[\underline{H(Pt)}]^2*[H_2O]/[H_{2aq}];$$

$$\Delta G_{Alberty}=G_{H2aq}-2G_{H(Pt)}-G_{H2O}=\mathbf{1.14}\ ^{kJ}/_{mol};$$

$K_{sp\_H(Pt)}=[H_{2aq}]/[\underline{H(Pt)}]^2/[H_2O]=EXP(-\Delta G_{sp\_H(Pt)}/R/T)=EXP(-\mathbf{1140}/8.3144/298.15)=0.631$ unfavored. [8]

Water oxidation to oxygen aqua $O_{2aqua}$ half reaction $5H_2O=O_{2aq}+4H_3O^++4e^-$ Hess free energy change is:

$\Delta G_{O2aqAlberty}=G_{O2aq}+4G_{H3O+}-5G_{H2O}=\mathbf{330}-4*\mathbf{22.44}-5*\mathbf{0}=\mathbf{419.76}\ ^{kJ}/_{mo}$ , because aqua mol fraction:

$O_{2gas\ AIR}+H_2O=O_{2aq}$ compensate sixth water molecule $6H_2O=O_{2gas\ AIR}+H_2O+4H_3O^++4e^-$ and Nernst's half reaction is: $5H_2O=O_{2aq}+4H_3O^++4e^-$ with absolute standard potential $E^\circ_{O2aq}=1{,}0610$ V.

It is identical to electrochemical calculation of free energy change minimum using absolute Nernst's standard potential $E^\circ_{O2aq}=1.0610$ Volts: $\Delta G_{eqO2aq}=E^\circ_{O2aq}\bullet F\bullet n_{e-}=1{,}0610*96485*4=\mathbf{409{,}5}\ ^{kJ}/_{mol}$ .

Hydrogen metal H(Pt) half reaction $\underline{H}(Pt)+H_2O<=>H_3O^++e^-$ Hess free energy change is:

$$\Delta G_{H(Pt)eqAlberty}=G_{H3O+}+G_{e-}-(G_{H(Pt)}+G_{H2O})=22.44+0-(\mathbf{51.05}+0)=-\mathbf{28.61}\ ^{kJ}/_{mol}\ .$$

It is identical to electrochemical calculation of free energy change minimum using **absolute** Nernst's standard potential $E^\circ_{H(Pt)}=-0.29654$ Volts :

$\Delta G_{eqH(Pt)}=E^\circ_{H(Pt)}\bullet F\bullet n_{e-}=-0.29654*96485*1=-\mathbf{28.61}\ ^{kJ}/_{mol}$ coinciding with Alberty data. [8,15]

0

Formation 41st from elements $\mathbf{O_{2gas}+H_{2gas}+H_2O=H_2O_{2aq}}$; $\Delta G^\circ_{UnivAlberta}=-134.03\ ^{kJ}/_{mol}$ ; $\Delta G^\circ_{Alberty}=\mathbf{-48.39}\ ^{kJ}/_{mol}$; $\Delta G_{H2O2Alberty}=G_{H2O2\ aq}-(G_{O2gas}+G_{H2gas}+G_{H2O}=)=\mathbf{\underline{284-(85.64+303}+0)=-104.64}\ ^{kJ}/_{mol}$ ;

$\mathbf{H_2O_2}_{aqua}$ dismutation Nernst's half reactions Red and Ox absolute standard free energy change sum is favored-spontaneous: $\mathbf{2H_2O_{2aq}=>O_{2aq}+2H_2O+Q+\Delta G}$ ;

$\Delta G_{eqStandardAbsolute}=(E^\circ_{H2O2aqRed}-E^\circ_{H2O2aqOx})\mathbf{*F*n=-238.5}\ ^{kJ}/_{mol}$ ;

$\Delta G_{Alberty}=G_{O2aqua}+2*G_{H2O}-2*G_{H2O2}=\mathbf{90.63\underline{-329.13}=-238.5}\ ^{kJ}/_{mol}$.

Reducton Nernst's: $\mathbf{H_2O_{2aqua}+2H_2O=O_{2aqua}+2H_3O^++2e^-}$; **absolute** potential $E^\circ_{H2O2aqRed}=0.4495$ V [20],

$\underline{\Delta G_{H2O2aqAlberty}=G_{O2aq}+2G_{H3O+}-G_{H2O2}-2G_{H2O}=\mathbf{330}+2*\mathbf{22.44-284.25}-2*\mathbf{0=100.38}\ ^{kJ}/_{mol}}$

$\Delta \mathbf{G_{eq}}_{H2O2}=E^\circ_{H2O2aq}\bullet F\bullet 2=0.4495*96485*2=\mathbf{86.7}\ ^{kJ}/_{mol}$

Oxidation **inverse** $H_2O_2+2H_3O^++2e=4H_2O$ ;absolute standard potential $-E^\circ_{H2O2aqOx}=-1.6855$ V Suhotina [18] ;

$\underline{\Delta G_{H2O2OxAlberty}=4*G_{H2O}-(G_{H2O2}+2*G_{H3O+})=4*\mathbf{0-(284.25}+2*\mathbf{22.44)=-319.38}\ ^{kJ}/_{mol}}$

$\Delta \mathbf{G_{eqOx}}_{H2O2}=-E^\circ_{H2O2aqOx}\bullet F\bullet 2=-1.6855*96485*2=\mathbf{-325.25}\ ^{kJ}/_{mol}$ ;

$\Delta G_{eqStandard\_2H2O2}=(E^\circ_{H2O2aqRed}-E^\circ_{H2O2aqOx})\mathbf{*F*n}=(0.4495-1.6855)*96485*2=(-1.236)*96485*2=\mathbf{-238.5}\ ^{kJ}/_{mol}$ ;

$\Delta G_{Alberty\_2H2O2}=G_{O2aqua}+2*G_{H2O}-2*G_{H2O2}=\mathbf{330+2*0}-2*G_{H2O2}=\mathbf{-238.5}\ ^{kJ}/_{mol}$;

$G_{H2O2}=(G_{O2aqua}+2*G_{H2O}+\Delta G_{Alberty\_2H2O2})/2=(\mathbf{330+2*0+238.5})/2=\mathbf{568.5}/2=\mathbf{284.25}\ ^{kJ}/_{mol}$ ;

**Absolute** energy content $G_{H2O2}=\mathbf{\underline{284.25}}\ ^{kJ}/_{mol}$ is detected on zero of $G_{H2O}=G_{CO2gas}=0\ ^{kJ}/_{mol}$ background . [8]

Formation of elements $\mathbf{H_{2gas}+O_{2gas}=>H_2O_2}$; $\Delta G^\circ_{UnivAlberta}=-134.03\ ^{kJ}/_{mol}$, $\Delta G^\circ_{Alberty}=\mathbf{-48.39}\ ^{kJ}/_{mol}$:

$\mathbf{H_{2gas}+O_{2gas}=>H_2O_2}$; $\Delta G_{Alberty}=G_{H2O2}-(G_{O2gas}+G_{H2gas})=\mathbf{\underline{284.25}-(303+85.64)=-104.4}\ ^{kJ}/_{mol}$ . 41st,54th page [1,8,20]

Homeostasis attractors pH=7.36, $[H_2O]$=55.3 M at peroxide concentration one. **Absolute** potential scale reduction **absolute** and oxidation **inverse** potentials sum $(E_{Red}-E_{oOx})=-1.26$ V shows **absolute** free energy content in one mol $G_{HomeostasisH2O2}=\mathbf{369.7}\ ^{kJ}/_{mol}$:

$E_{Red}=E^\circ_{RedH2O2}+0.0591/2\bullet lg([O_{2aqua}]*[H_3O^+]^2/[H_2O_2]/[H_2O]^2)=0.4495+0.0591/2*log(6*10^{\wedge(-5)}*10^{\wedge(-7.36*2)}/1/55.3^{\wedge 2})=-0.213$ V

$-E_{Ox}=-E^\circ_{H2O2Ox}+0.0591/2\bullet log([H_2O_2]*[H_3O^+]^2/[H_2O]^4)=-1.6855+0.0591/2*log(1*10^{\wedge(-7.36*2)}/55.3^{\wedge 4})=-2.3265$ V

Homeostasis: $\Delta \mathbf{G_{eq}}_{BioChem}=(E_{Red}-E_{oOx})\mathbf{*F*n}=(-0.2132-2.3265)*96485*2=(-2.5397)*96485*2=\mathbf{-490.1}\ ^{kJ}/_{mol}\mathbf{242.7}$

$\Delta G_{AlbertyBioChem}=G_{O2Biochem\_arteriaj}+2*G_{H2OBioChemistry}-2*G_{H2O2}=\mathbf{78.08+2*85.64}-2*G_{BioC\_H2O2}=\mathbf{-490.1}\ ^{kJ}/_{mol}$; [8]

$2*G_{HomeostasisH2O2}=G_{O2Biochem\_arteriaj}+2*G_{H2OBioChemistry}-\Delta G_{Alberty}=\mathbf{78.08+2*85.64+490.1}=2*\mathbf{369.7=739.5}\ ^{kJ}/_{mol}$

Peroxide high rate protolysis $\mathbf{H_2O+H_2O_2=H_3O^++HOO^-}$ equilibrium constant calculates from pKa=11.75:

$\mathbf{K_{eq}}_{H2O2}\mathbf{=K_a/[H_2O]=[H_3O^+][HOO^-]/[H_2O]/[H_2O_2]}=10^{\wedge(-11.57)}/55.3=10^{\wedge(-13.31)}$ , $p\mathbf{K_{eq}}_{H2O2}=13.31$. [1]

**Absolute** free energy change minimum **75.97** $^{kJ}/_{mol}$ let's to calculate peroxide anion energy content in mol $G_{HOO-}$:

$\Delta \mathbf{G_{eq}}_{H2O2}=-R\bullet T\bullet ln(\mathbf{K_{eq}}_{H2O2})=-8.3144*298.15*ln(10^{\wedge(-13.31)})/1000=\mathbf{75.97}\ ^{kJ}/_{mol}$ .

$\Delta \mathbf{G_{eq}}_{H2O2}=G_{H3O+}+G_{HOO-}-G_{H2O}-G_{H2O2}=\mathbf{75.97}\ ^{kJ}/_{mol}$ .$\Delta \mathbf{G_{eq}}_{H2O2}=\mathbf{22.44}+G_{HOO-}\mathbf{-0-284.25=75.97}\ ^{kJ}/_{mol}$ .

Anion energy in mol is $G_{HOO-}=\Delta \mathbf{G_{eq}}_{H2O2}+G_{H2O}+G_{H2O2}-G_{H3O+}=\mathbf{-22.44+75.97}+0+\mathbf{284.25=\underline{337.8}}\ ^{kJ}/_{mol}$.

Electrochemical anion $\mathbf{HOO^-}$ oxidation **absolute** standard potential is $E^\circ_{HOo-aqAlberty}=0.07587$ Volts.
Free energy change of oxidation is positive endoergic with low **absolute** standard potential:

$\Delta G_{HOO-aqAlberty}=G_{O2aq}+G_{H3O+}-(G_{HOO-}+G_{H2O})=\mathbf{330+22.44-(337.8}+\mathbf{0)=14.64}\ ^{kJ}/_{mol}$.

$\mathbf{HOO^-+H_2O=O_{2aqua}+H_3O^++2e^-}$; $E^\circ_{HOO-aq}=\Delta G_{HOo-aqAlberty}/F/2=\mathbf{14640}/96485/2=0.07587$ V.

$G_{H2O2}=\mathbf{\underline{284.25}}\ ^{kJ}/_{mol}$; $G_{H3O+}+G_{HOO-}=22.44+\mathbf{\underline{337.8}}=360.24\ ^{kJ}/_{mol}$

| **Table 1.**<br>Nernst's half- / **inverse** reactions  Standard potentials E° Data from [1-24] | Classic water disaccount 0 V | Thermodynamic. scale 0.10166 V | Absolute -0.3982 V |
|---|---|---|---|
| $OH^- = HO + e^-$ CRC | 2.020 | 2.1217 | 1.7235 |
| $4H_2O=H_2O_{2aqua}+2H_3O^++2e^-$ Suchotina | 1.776 | 2.0837 | 1.6855 |
| $H_2O_2+2H_2O=O^-_{2aqua}+2H_3O^++e^-$ David Harris | 1.276 | 1.4811 | 1.0829 |
| $6H_2O=O_{2g}+H_2O+4H_3O^++4e^-$; $5H_2O=O_{2aq}+4H_3O^++4e^-$; | 1,2288 | 1,45814 | 1,0868 |
| $HNO_2+4H_2O=NO_3^-+3H_3O^++2e^-$ University Alberta | 0.928 | 1.2352 | 0.8370 |
| $NO_2^-+3H_2O=NO_3^-+2H_3O^++2e^-$ David Harris | 0.835 | 1.0913 | 0.6931 |
| Hydroquinone$+2H_2O=$p-quinone$+2H_3O^++2e^-$ | 0.699 | 0.9041 | 0.5059 |
| $H_2O_{2aqua}+2H_2O=O_{2aqua}+2H_3O^++2e^-$ University Alberta | 0.695 | 0.8477 | 0.4495 |
| $H_2O_{2aqua}+H_2O=O_{2aqua}+H_3O^++H^-$ University Alberta | 0.695 | 0.8477 | 0.4495 |
| $Fe^{2+}=Fe^{3+}+e^-$ University Alberta | 0.769 | 0.8707 | 0.4725 |
| Ubiquinol$+2H_2O=$Ubiquinone$+2H_3O^++2e^-$ | 0.459 | 0.6638 | 0.2656 |
| Succinate$^{2-}+2H_2O=$Fumarate$^{2-}+2H_3O^++2e^-$ | 0.4447 | 0.6494 | 0.2512 |
| ButyrylCoA$+2H_2O=$CrotonylCoA$+2H_3O^++2e^-$ | 0.399 | 0.6038 | 0.2056 |
| AscorbicAcid$+2H_2O=C_6H_6O_6+2H_3O^++2e^-$ DC.Harris | 0.390 | 0.5947 | 0.1965 |
| glycolate$+2H_2O=$Glyoxylate$+H^-+H_3O^+$ D.C.Harris | 0.324 | 0.5287 | 0.1305 |
| $C_6H_{12}O_6+42H_2O=24H_3O^++6H_3O^++6HCO_3^-+24e^-$, 6. lapa Kaksis | 0,4089 | 0,51054 | 0,1392 |
| $HOO^-+H_2O=O_{2aqua}+H_3O^++2e^{--}$ Aris Kaksis | - | - | 0.07587 |
| $Fe^{2+}=$Cytochrome F $Fe^{3+}+e^{--}$David Harris | 0.365 | 0.4667 | 0.0685 |
| $[Fe^{II}(CN)_6]^{4-}=[Fe^{III}(CN)_6]^{3-}+e^-$ University Alberta | 0.356 | 0.4574 | 0.0592 |
| Malate$^{2-}+2H_2O=$Oxalo-acetate$^{2-}+2H_3O^++2e^-$ | 0.248 | 0.4528 | 0.0546 |
| $Fe^{2+}=$Cytochrome a3 $Fe^{3+}+e^-$ | 0.350 | 0.4517 | 0.0535 |
| Lactate$^-$ $+H_2O=$Pyruvate$^-+H_3O^++H^-(H^++2e^-)^-$ | 0.229 | 0.3823 | -0.0159 |
| $FADH_2+2H_2O=$FADfree$+2H_3O^++2e^-$; | 0.195 | 0.3998 | 0.0016 |
| $CH_3COO^-+2H_2O=$glycolate$+H^-+H_3O^+$; D.C.Harris | 0.161 | 0.3652 | -0.0330 |
| $H_2S_{aq}+2H_2O=S_{rhombic}+2H_3O^++2e^-$; CRC 2010 | 0.142 | 0.3467 | -0.0515 |
| $Fe^{2+}=$Cytochrome a $Fe^{3+}+e^-$ | 0.2900 | 0.3917 | -0.0065 |
| 2GlutathSH$+2H_2O=$GlutaS-Sthione$+2H_3O^++2e^-$ | 0.1841 | 0.3888 | -0.0094 |
| $Fe^{2+}=$Cytochrome c $Fe^{3+}+e^-$ | 0.2540 | 0.3557 | -0.0425 |
| LipSHSH$+2H_2O=$LipoicAcidS-S$+2H_3O^++2e^-$ | 0.1241 | 0.3288 | -0.0694 |
| $Fe^{2+}=$Cytochrome c1 $Fe^{3+}+e^-$ | 0.2200 | 0.3217 | -0.0765 |
| β-OH Butyrate$^-+2H_2O=$AcetoAcetate$^-+2H_3O^++2e^-$ | 0.0681 | 0.2728 | -0.1254 |
| isocitrate$^{2-}+2H_2O=\alpha$-Ketoglutarate$^{2-}+CO_2+2H_3O^++2e$- | 0.0341 | 0.2388 | -0.1594 |
| Nernst's $H_{2aq}+2H_2O=2H_3O^++2e^-$; Kaksis $\Delta G_{Hess\_H3O+}=$-58,12 kJ/mol | on graphite electrode oxidation | | -0.3020 |
| **Inverse:** $2H_3O^++2e^-=H_{2aq}+2H_2O$; $\Delta G_{Hess_H2aq}=$58,12 kJ/mol | on graphite electrode reduction | | 0.3020 |
| $H_{2aq}=2\underline{H(Pt)}+H_2O$; $\Delta G_{Alberty\_sp\_H(Pt)}=2G_{H(Pt)}+G_{H2O}-(G_{H2aq})=$**-1.14** kJ/mol | $K_{sp\_H(Pt)}=[\underline{H(Pt)}]^2*[H_2O]/[H_{2aq}]=1.584$ | | |
| $H(Pt)+H_2O=H_3O^++e^-$; $[H_3O^+]=1$ M pH=0 classic zero | 0; $[H_2SO_4]=1$ M | 0.10166 | **-0.2965** |
| Luciferin$+OH^-=$?luciferin$+CO_{2\ aqua}+OH^-+3H(3H^++3e^-)+e^-$ | 0.0000 | 0.1017 | -0.2965 |
| $Fe^{2+}=$Cytochrome b $Fe^{3+}+e^-$ | 0.0770 | 0.1787 | -0.2195 |
| $CH_3CHO+3H_2O=CH_3COOH+2H_3O^++2e^-$ Suchotina | -0.1180 | 0.1382 | -0.2600 |
| Glycaldeh3-P$^{2-}+H_2O+HPO_4^{2-}=$13PGlycerate$^{4-}+H_3O^++H^-$; | -0.1314 | 0.0218 | -0.3764 |
| NADPH=NADP$^++H^-$; | -0.1170 | -0.0153 | -0.4135 |
| NADH=NAD$^++H^-$; David Harris | -0.1130 | -0.0113 | -0.4095 |
| $O^-_{2aqua}=O_{2aqua}+e$- Suchotina | -0.2450 | -0.1433 | -0.5415 |
| Ferredoxin $Fe^{2+}=$Ferredoxin $Fe^{3+}+e^-$ | -0.4320 | -0.3303 | -0.7285 |
| $C_6H_{12}O_6+4H_2O=2C_3H_4O_3+4H_3O^+ + 4e^-$ Stryer | -0.5427 | -0.3380 | -0.7362 |
| $S^{2-}=S_{rhombic}+2e^-$; CRC 2010 | -0.4763 | -0.3746 | -0.7728 |
| $HS^-+OH^-=S_{rhombic}+H_2O+2e^-$; CRC 2010 | -0.4780 | -0.3248 | -0.7230 |
| $H(Pt)+OH^-=H_2O+e^-$ Suchotina | -0.8280 | -0.6233 | -1.0215 |
| Ubiquinol6$+2H_2O=$Ubiquinone6$+2H_3O^++2e^-$ CRC 2012 | -1.0500 | -0.8453 | -1.2435 |

0

**Potential scale** conversion on water account and hydrogen electrode correction to **absolute scale** example.
Classic disaccount water Nernst's oxygen half reaction: $6H_2O=O_{2aqua}+4H_3O^++4e^-$ $E^\circ_{O2classic}=1.229$ V. [18]
Water account potential: $E^\circ_{6H2O}=E^\circ_{O2classic}-0.0591/4\bullet\log(1/[H_2O]^6)=1.229-0.014775*\log(1/55.3\wedge^{6})=1,383$ V.
Hydrogen electrode correction +0.10166: $E^\circ_{O2Thermodynamic}=E^\circ_{6H2O}+0.10166=1.383+0.10166=1.485$ Volts.
On **scale** of **Absolute** standard **Potential** is $E^\circ_{O2Absolute}=E^\circ_{O2Thermodynamic}-0.3982=1.485-0.3982=1.0868$ Volts.

Formation from elements $N_{2gas}+3H_{2gas}>2NH_{3gas}$ absolute energy are $G_{N2gas}=\mathbf{107.28}$ kJ/mol; ; $G_{NH3gas}=\mathbf{165.7}$ kJ/mol ;
Classic Hess elements have zero $2\Delta G_{Hess\_NH3gas}=2G^\circ_{NH3gas}-(G^\circ_{N2gas}+3*G^\circ_{H2})=2*-16.4-(\mathbf{0}+3*0)=-32.8$ kJ/mol . [1]
Alberty element hydrogen $G_{H2gas}=\mathbf{85.64}$ kJ/mol **absolute** energy with Hess change -32.8 kJ/mol calculates nitrogen **absolute** energy $G_{N2gas}=2G_{NH3gas}-(2\Delta G_{Hess\_NH3gas}+3*G_{H2gas})=2*\mathbf{165.7}-(2*-16.4+3*\underline{\mathbf{85.64}})=\mathbf{107.28}$ kJ/mol . [8]
$\Delta G_{HessFormationN2aqua}=G_{N2aqua}-(G_{N2gas}+G_{H2O})=\mathbf{18.7}-(\mathbf{107.28}+0)=\mathbf{-88.5}$ kJ/mol; [8]
$G_{N2gas}=G_{N2aqua}-(\Delta G_{Hess\_sp\_N2aqua}+G_{H2O})=\mathbf{18.7}-(\mathbf{-88.5}+0)=\mathbf{107.2}$ kJ/mol; [8] Alberty

| *Substance* | $\Delta H^\circ_H$ kJ/mol | $\Delta S^\circ_H$ J/mol/K | $\Delta G^\circ_H$ kJ/mol |
|---|---|---|---|
| $NH_{3gas}$ | -45.9 | 192.77 | -16.4 |
| $NH_{3gas}$ | | | **438.85** |
| $NH_{3aq}$ | **-132.5608** | **-739.2922** | **91.1056** |
| $N_{2gas}$ | $G_{N2gas}=$ | **-15.26** | **107.2** |
| $N_{2aq}$ | **–10.54** | **98.1** | **18.7** |

$N_{2gas}+3H_{2gas}>2NH_{3gas}$;
$G_{N2gas}=2*\mathbf{165.6593}-(-32.8+3*\underline{\mathbf{85.64}})=\mathbf{107.2}$ kJ/mol; [8] **Alberty**;
$G_{N2gas}=2G_{NH3gas}-(2\Delta G_{Hess\_NH3gas}+3*G_{H2gas})=\mathbf{107.2}$ kJ/mol; [8] **Alberty**;

Hundred grams of water dissolute nitrogen gas 0.00175 $^{g}/_{100g\_H2O}$ density has 996 g/L.
Solubility $[N_{2aqua}]=0.00175/100.00175*996=0.01743/28.02=10^{-3.206}$ M and solubility product constant is:
$K_{sp}=10\wedge^{(-4.206)}/[H_2O]=10\wedge^{(-3.206)}/55.3=10^{-4.949}$; $\Delta G_{sp}=-R\bullet T\bullet\ln(K_{sp})=-8.3144*298.15*\ln(10\wedge^{(-4.949)})=\mathbf{28.25}$ kJ/mol .
Mol of free energy is $G_{N2gas}=G_{N2aqua}-(\Delta G_{Hess\_sp\_N2aqua}+G_{H2O})=\mathbf{18.7}-(\mathbf{28.25}+0)=\mathbf{-9.55}$ kJ/mol ; CRC 2010 [1,8]

Solubility $N_{2gas}+H_2O+\Delta G=N_{2aq}+Q$; $G_{N2gas}=\mathbf{-9.55}$ kJ/mol ; CRC 2010 [1,8] Alberty
$\Delta G_{Hess\_sp\_N2aqua}=G_{N2aqua}-(G_{N2gas}+G_{H2O})=\mathbf{18.7}-(\mathbf{-9.55+0})=\mathbf{28.25}$ kJ/mol;
Solubility product $K_{sp}=[N_{2aqua}]/[H_2O]=10\wedge^{(-3.206)}/55.3=10^{-4.949}$ , which free energy change minimum is
$\Delta G_{sp}=-R\bullet T\bullet\ln(K_{sp})=-8.3144*298.15*\ln(10\wedge^{(-4.949)})=\mathbf{28.25}$ kJ/mol .
Hess law free energy change is coincident with
$\Delta G_{Hess\_sp\_N2aqua}=G_{N2aqua}-(G_{N2gas}+G_{H2O})=\mathbf{18.7}-(G_{N2gas}\ \mathbf{-0})=\mathbf{28.25}$ kJ/mol.
Expressed nitrogen gas free energy content is
$G_{N2gas}=G_{N2aqua}-(\Delta G_{Hess\_sp\_N2aqua}+G_{H2O})=\mathbf{18.7}-(\mathbf{28.25}+0)=\mathbf{-9.55}$ kJ/mol negative.

Solubility $NH_{3gas}+H_2O+\Delta G\Leftarrow\!\!\!=\!\!\!\Rightarrow NH_{3aq}+Q$; $G_{NH3aq}=\mathbf{91.1}$ kJ/mol;
$\Delta H_{Hydration}=\Delta H^\circ_{NH3aq}-\Delta H^\circ_{NH3gas}-\Delta H^\circ_{H2O}=\mathbf{-132.5608}+45.94\mathbf{-286.65}=373.3$ kJ/mol;
$S_{Hydration}=\Delta S^\circ_{NH3aqua}-\Delta S^\circ_{NH3gas}-\Delta S^\circ_{H2O}=\mathbf{-739.2922}-192.77-69.9565\mathbf{=-1002}$ J/mol/K;
$\Delta G_{Hess\_NH3gas}=\Delta H_{Hydrations}-T*\Delta S_{Hydration}=-373.3\mathbf{-298.15*-1.002=-74.5537}$ kJ/mol;
$\mathbf{K_{sp}=exp(-\Delta G_{Hydration}/R/T)=exp(74553.7/8.3144/298.15)=10^{13.06}}$
$G_{NH3gas}=\Delta G_{NH3aq}-(\Delta G_{Hess\text{-}sp\text{-}NH3gas}+G_{H2O})=\mathbf{91.1056}-(\mathbf{-74.5537}+0)=\mathbf{165.7}$ kJ/mol; [8] **Alberty**
$G_{NH3gas}=(2\Delta G_{Hess\_NH3gas}+(G_{N2gas}+3*G_{H2}))/2=(-32.8+(\mathbf{107.2}+3*\underline{\mathbf{85.64}}))/2=\mathbf{165.7}$ kJ/mol; Hess [1,8] Alberty
$G_{NH3gas}=\Delta G^\circ_{NH3aq}-\Delta G_{Hess\text{-}sp\text{-}NH3gas}-G^\circ_{H2O}=\mathbf{91.1056}-(\mathbf{-74.5537})-(-0)=\mathbf{165.7}$ kJ/mol; [8] Alberty
$G_{NH3gas}=\Delta G^\circ_{NH3aq}-\Delta G_{Hess\_NH3gas}-G_{H2O}=\mathbf{91.1056}-(\mathbf{-74.5537})-(-273.19)=\mathbf{438.85}$ kJ/mol ; CRC 2010

Weak acid protolysis progress $NH_4^++H_2O=NH_{3aq}+H_3O^+$; $pK_{eq}=10.99$; shows energy $G_{NH4+}=\mathbf{232.9}$ kJ/mol,
$\Delta G_{eq}=-R\bullet T\bullet\ln(K_{eq})=-8.3144*298.15*\ln(10\wedge^{(-10.99)})=G_{NH3Hydration}+G_{H3O}-G_{NH4+}-G_{H2O}=62.76$ kJ/mol , 16th page:
$\Delta G_{eq}=G_{NH3aq}+G_{H3O}-G_{NH4+}-G_{H2O}=\mathbf{91.1}+22.44-G_{NH4+}\mathbf{-0}=62.75$ kJ/mol,
$G_{NH4+}=G_{NH3aq}+G_{H3O}-\Delta G_{eq}-G_{H2O}=\mathbf{91.1}+22.44-62.75\mathbf{-0=232.9}$ kJ/mol,
$\mathbf{K_{eq3}}$; protolīze $NH_4^++H_2O+\Delta G+Q\Rightarrow NH_{3aq}+H_3O^+$; $pK_{eq}=10.9944$; $NH_4^+=H^++NH_{3aqua}$ ; $pK_a=9.25$;
$K_{eq3}=[NH_{3aq}]*[H_3O^+]/[NH_4^+]/[H_2O]=exp(-\Delta G_{Hydration}/R/T)=exp(-62755.6/8.3144/298.15)=10^{-10.994}$;
$\Delta G_{eq3}=-R\bullet T\bullet\ln(K_{eq})=-8.3144\bullet298.15\bullet\ln(1.013*10^{-11})=62.75$ kJ/mol;
$\mathbf{K_{eq3}}=[NH_{3aq}]*[H_3O^+]/[NH_4^+]/[H_2O]=[H_2O]*K_{H2O}/K_{NH4OH}=55.3*3.26*10\wedge^{(-18)}/1.78/10\wedge^{(-5)}=1.013*10\wedge^{(-11)}$ ;
$\Delta G_{Hydration}=\Delta G_{NH3aq}-\Delta G_{NH3gas}-G_{H2O}=\mathbf{91.1056}-(-16.4-0)=\mathbf{107.5}$ kJ/mol ;
$G_{NH3aq}=\Delta G_{Hydration}+G_{NH3gas}+G_{H2O}=\mathbf{107.5+165.7}+0=\mathbf{273.2}$ kJ/mol ;

0

## Table 2. Nernst's half reactions Standard Electrodes Potentials classic, Thermodynamic and absolute in V

| | Reduced form = Oxidized form | $H_2O$ disaccount classic zero $E_o=0$ | Thermodynamic. scale $E_{oH}=0.10166$ V | Absolut scale -0.3982 V |
|---|---|---|---|---|
| **N** | $NO_2^- + 2OH^- = NO_3^- + H_2O + \mathbf{2e}^-$; pH>3.15 Suchotina [17] | 0.01 | 0.0602 | -0.3380 |
| | $HNO_2 + 4H_2O = NO_3^- + 3H_3O^+ + \mathbf{2e}^-$; pH<3.15 Kortly, Shucha | 0.94 | 1.2477 | 0.8495 |
| | $NO_{aq} + 6H_2O = NO_3^- + 4H_3O^+ + \mathbf{3e}^-$; pH>3.15 Kortly, Shucha | 0.96 | 1.1777 | 0.7795 |
| | $NH_4^+ + 13H_2O = NO_3^- + 10H_3O^+ + \mathbf{8e}^-$; Suchotina [17] | 0.87 | 1.1390 | 0.7408 |
| **Br** | $2Br^- = Br_2(aq) + \mathbf{2e}^-$; CRC | 1.0873 | 1.18896 | 0.79076 |
| **Bi** | $Bi\,O^+ + 6H_2O = BiO_3^- + 4H_3O^+ + \mathbf{2e}^-$; Suchotina | 1.80 | 2.210645 | 1.81245 |
| **Mn** $H^+$ | $Mn^{2+} + 12H_2O = MnO_4^- + 8H_3O^+ + \mathbf{5e}^-$; Kortly, Shucha [18] | 1.51 | 1.858848 | 1.460648 |
| $\mathbf{H_2O}$ | $\underline{MnO_2}\downarrow + 4OH^- = MnO_4^- + 2H_2O + \mathbf{3e}^-$; Suchotina [17] | 0.603 | 0.635997 | 0.237797 |
| $\mathbf{OH^-}$ | $MnO_4^{2-} = MnO_4^- + \mathbf{e}^-$; Suchotina | 0.558 | 0.65966 | 0.26146 |
| **Pb** | $Pb^{2+} + 6H_2O = \underline{PbO_2}(s) + 4H_3O^+ + \mathbf{2e}^-$; Kortly, Shucha | 1.455 | 1.865645 | 1.467445 |
| **S** | $H_2SO_3 + 4H_2O = HSO_4^- + 3H_3O^+ + \mathbf{2e}^-$; Suchotina pH<1.9 | 0.172 | 0.47965 | 0.08145 |
| **S** | $HSO_3^- + 4H_2O = SO_4^{2-} + 3H_3O^+ + \mathbf{2e}^-$; Suchotina 2=<pH<7 | 0.172 | 0.47965 | 0.08145 |
| | $SO_3^{2-} + 2OH^- = SO_4^{2-} + H_2O + \mathbf{2e}^-$; Suchotina pH > 7 | -0.93 | -0.87984 | -1.27804 |
| | $S^{2-} \underline{=S}(s) + \mathbf{2e}^-$; Kortly, Shucha | -0.48 | -0.37834 | -0.77654 |
| | $H_2S + 2H_2O \underline{=S}(s) + 2H_3O^+ + \mathbf{2e}^-$; Kortly, Shucha | 0.141 | 0.345655 | -0.05254 |
| | $2S_2O_3^{2-} = S_4O_6^{2-} + \mathbf{2e}^-$; Suchotina | 0.08 | 0.18166 | -0.2165 |
| **Fe** | $Fe^{2+} = Fe^{3+} + \mathbf{e}^-$; Suchotina [17] | 0.769 | 0.8717 | 0.4735 |
| | $Fe(s) + H_2O = Fe^{2+} + \mathbf{2e}^-$; Suchotina | -0.4402 | -0.2870 | -0.6852 |
| **Ag** | $Ag + H_2O = Ag^+ + \mathbf{e}^-$; Kortly, Shucha [18] | 0.7994 | 1.0041 | 0.6059 |
| | $\mathbf{Ag}(s) + Cl^- = \mathbf{Ag}Cl(s) + H_2O + e^-$; Kortly, Shucha | 0.2223 | 0.2210 | -0.1772 |
| | $Ag + 2NH_{3(aq)} = Ag(NH_3)_2^+ + \mathbf{e}^-$; Suchotina | 0.373 | 0.4747 | 0.0765 |
| | $2Ag + 2OH^- = \mathbf{Ag_2O}(s) + H_2O + \mathbf{2e}^-$; Suchotina | 0.345 | 0.3952 | -0.0030 |
| **I** | $3I^- = I_3^- + \mathbf{2e}^-$; Kortly, Shucha | 0.6276 | 0.72926 | 0.33106 |
| **Cu** | $Cu(Hg) = Cu^{2+} + (Hg) + \mathbf{2e}^-$; Kortly, Shucha | 0.3435 | 0.4967 | 0.0985 |
| **F** | $2F^- = F_2(g) + \mathbf{2e}^-$; Kortly, Shucha | 2.87 | 2.97166 | 2.5735 |
| **Cl** | $2Cl^- = Cl_2(g) + \mathbf{2e}^-$; Kortly, Shucha | 1.358 | 1.45966 | 1.06146 |
| | $Cl_2(g) + 4H_2O = 2HOCl + 2H_3O^+ + \mathbf{2e}^-$; Kortly, Shucha | 1.63 | 1.93765 | 1.53945 |
| **Cr** | $2Cr^{3+} + 21H_2O = Cr_2O_7^{2-} + 14H_3O^+ + \mathbf{6e}^-$;1<pH<7 Kortly,Shucha | 1.33 | 1.7921 | 1.3939 |
| | $Cr^{3+} + 11H_2O = HCrO_4^- + 7H_3O^+ + \mathbf{3e}^-$; pH>7 Kortly, Shucha | 1.20 | 1.6793 | 1.2811 |
| | $\underline{Cr(OH)_3}\downarrow + 5OH^- = CrO_4^{2-} + 4H_2O + 3e^-$; pH>9 ; Suchotina [17] | -0.13 | -0.1657 | -0.5639 |
| **C** | $H_2C_2O_4 + 2H_2O = 2CO_2 + 2H_3O^+ + \mathbf{2e}^-$; Suchotina | -0.49 | -0.2853 | -0.6835 |
| **Cr** | $Cr + H_2O = Cr^{3+} + \mathbf{3e}^-$; Suchotina | -0.744 | -0.6080 | -1.0062 |
| **Zn** | $Zn + H_2O = Zn^{2+} + \mathbf{2e}^-$; Kortly, Shucha | -0.7628 | -0.6096 | -1.0078 |
| **Al** | $Al + 4OH^- = H_2AlO_3^- + H_2O + \mathbf{3e}^-$; Suchotina | -2.35 | -2.2827 | -2.68087 |

Glc 6th page Formation from elements $\mathbf{C} + 6\mathbf{H_{2gas}} + 3\mathbf{O_2}_{gas} = \mathbf{C_6H_{12}O_6}$ free energy change calculates from Alberty data $\Delta\mathbf{G}^\circ_{Alberty} = \mathbf{G_{C6H12O6}} - (\mathbf{6G_{Cgraph}} + \mathbf{6*}G_{H2gas} + \mathbf{3*}G_{O2gas}) = \mathbf{-402.05}$ kJ/mol ;

$\Delta\mathbf{G}^\circ_{Alberty} + (\mathbf{6G_{Cgraph}} + \mathbf{6*}G_{H2gas} + \mathbf{3*}G_{O2gas}) = \mathbf{-402.05 + (6*91.26 + 6*85.6 + 3*303)} = \mathbf{G_{C6H12O6} = 1568}$ kJ/mol ;

**Glucose (Glc)** $\mathbf{C_6H_{12}O_6}$, with biochemical water $\mathbf{6H_2O}$ and oxygen $\mathbf{6O_2}_{aqua}$ reducing creates energy change $\Delta\mathbf{G}_{Lehninger} = -2840$ kJ/mol producing $\mathbf{6HCO_3^-}$and $\mathbf{6H_3O^+}$ ions generating concentrations gradients across membranes driving osmosis and transport of ions through aquaporins, bicarbonate and proton channels in membranes.

Free energy of glucose (**Glc**) $\mathbf{G_{C6H12O6}}$ at quasi equilibrium calculates one using Lehninger data [6]:

$$\mathbf{C_6H_{12}O_6} + 6\mathbf{O_2}_{aqua} + 6\mathbf{H_2O} = 6\mathbf{H_3O^+} + 6\mathbf{HCO_3};\ \Delta\mathbf{G}_{Lehninger} = -2840 \text{ kJ/mol}.$$

Energy $\underline{-2840} = -\mathbf{G_{C6H12O6}} - \mathbf{6*}G_{O2Homeostasis\_arterial} - \mathbf{6*}G_{H2O\_Biochem} + (6*G_{H3O+} + 6*G_{HCO3-})$ let us express glucose $\mathbf{G_{C6H12O6}} = \underline{2840} - \mathbf{6*}G_{O2Homeostasis\_arterial} - \mathbf{6*}G_{H2O\_Biochem} + 6*(G_{H3O+} + G_{HCO3-}) = \mathbf{757.28}$ kJ/mol standard quasi equilibrium change $\mathbf{G_{C6H12O6}} = \underline{2840} - 6*\mathbf{330} - 6*\mathbf{85.64} + 6*(\mathbf{22.44} + \mathbf{46.08}) = \mathbf{757.28}$ kJ/mol and free energy change at homeostasis $\mathbf{G_{C6H12O6}} = \underline{2840} - 6*\mathbf{78.08} - 6*\mathbf{85.64} + 6*(\mathbf{22.44} + \mathbf{46.08}) = 2268.8$ kJ/mol . Glucose free energy contents are standard $\mathbf{G_{C6H12O6}} = \mathbf{757}$ kJ/mol and homeostasis Lehninger based $\mathbf{G_{C6H12O6}} = 2268.8$ kJ/mol. [8,6]

Generated $\mathbf{6HCO_3^-} + \mathbf{6H_3O^+}$ ions drive $6\mathbf{O_2}_{aqua} + 6\mathbf{H_2O}$ through membranes aquaporins channels for osmosis against the concentration gradients but transporting ions $\mathbf{6HCO_3^-} + \mathbf{6H_3O^+}$ down the gradients through membrane bicarbonate and proton channels using produced homeostasis free energy of $\Delta\mathbf{G}_{Lehninger} = -2840$ kJ/mol.

Potentials difference $\Delta \mathbf{E}=\Delta \mathbf{G}_{eq}/\mathbf{F}/\mathbf{n}=(\mathbf{E}^\circ_{C6H12O6}-\mathbf{E}^\circ_{O2})=-2840000/96485/24=-1.2264$ V give the absolute standard potential $\mathbf{E}^\circ_{C6H12O6}=\Delta \mathbf{E}+\mathbf{E}_{O2}=-1.226+1.0868=-0.1392$ V for glucose from Lehninger **-2840** $^{kJ}/_{mol}$. [6]

Nernst's half reaction $C_6H_{12}O_6+42H_2O=30H_3O^++6HCO_3^-+24\,e^-$ has standard potential $\mathbf{E}^\circ_{C6H12O6}=-0.1392$ V : Alberty data coincident with **absolute** potential scale. On oxygen reduction: $O_{2aqua}+4H_3O^++4e^-=6H_2O$ **inverse** standard potential $-E^\circ_{O2}=-1.0868$ V is **inverse**, because products are water molecules non oxygen:

$$\Delta G_{O2aqAlberty}=6G_{H2O}-(G_{O2aq}+4G_{H3O+})=\mathbf{6*0-(330}-4*\mathbf{22.44})=\mathbf{-419.76}\ ^{kJ}/_{mol}:$$

**Absolute** energy change minimum $\Delta \mathbf{G}_{eqStandardO2}=-E^\circ_{O2}\bullet F\bullet 1\bullet 4=-1.0868*96485*4=\mathbf{-419.44}\ ^{kJ}/_{mol}$ with six oxygen molecules half reactions oxidizing glucose (**Glc**) release energy change $\Delta \mathbf{G}_{Homeostasis}=-2840\ ^{kJ}/_{Cmol}$.

Standard $\Delta \mathbf{G}_{AlbertyAbsoluteC6H12O6}=\mathbf{E}^\circ_{C6H12O6}\bullet F\bullet 1\bullet 24=\mathbf{-0.}1392*96485*24=\mathbf{-322}\ ^{kJ}/_{mol}$ is exoergic **absolute** free energy change. Sum of half reactions shows coincidence Alberty data with **absolute** potential scale:

$$6\Delta \mathbf{G}_{eqStandardO2}=6*\mathbf{-419.44=-2516.6}\ ^{kJ}/_{mol}\ ;\ 6\Delta G_{O2aqAlberty}=\mathbf{6*-419.76=-2518.6}\ ^{kJ}/_{mol};$$

$$6\Delta \mathbf{G}_{eqStandardO2}+\Delta \mathbf{G}_{AlbertyAbsoluteC6H12O6}=\mathbf{-2516.6-322=-2838.94}\ ^{kJ}/_{mol}\ ;$$

**Inverse** Standard potential $-E^\circ_{O2}=-1.0868$ V with homeostasis attractors $[H_3O^+]=10^{\wedge(-7.36)}$ M, $[HCO_3^-]=\mathbf{0.0154}$ M, $[C_6H_{12}O_6]=5*10^{\wedge(-3)}$ M, $[O_{2aqua}]=6*10^{-5}$M, $[H_2O]=55.3$ M create **absolute** potentials sum for oxygen and glucose more exoergic $\Delta \mathbf{G}_{Lehninger}=\mathbf{-2840}\ ^{kJ}/_{mol}<\Delta \mathbf{G}_{Homeostasis}=\mathbf{-3054.7}\ ^{kJ}/_{mol}$ :

$$\mathbf{E}_{O2}=-E^\circ_{O2}+{}^{0.0591}/_{4}\bullet\log([H2O]^6/[O_{2aqua}]/[H_3O^+]^4)=-1.0868+{}^{0.0591}/_{4}*\log(55.346^{\wedge 6}/6/10^{\wedge(-5)}/10^{\wedge(-7.36*4)})=-0.4349\ V$$

$$\text{and: }\mathbf{E}_{C6H12O6}=E^\circ_{C6H12O6}+{}^{0.0591}/_{24}\bullet\log([HCO_3^-]^6\bullet[H_3O^+]^{30}/_{[C6H12O6]}/_{[H2O]}{}^{42})=$$

$$=-0.1392+{}^{0.0591}/_{24}*\log(\mathbf{0.0154^{\wedge 6}}*10^{\wedge(-7.36*30)}/5/10^{\wedge(-3)}/_{55.346}{}^{\wedge 42})=\mathbf{-0.8843}\ \text{Volts}\ .$$

Free energy change are exoergic, negative values at standard and homeostasis conditions:

$$\Delta \mathbf{G}_{Lehninger}=\Delta \mathbf{E}\bullet\mathbf{F}\bullet\mathbf{n}=(\mathbf{E}^\circ_{C6H12O6}-\mathbf{E}^\circ_{O2})\bullet\mathbf{F}\bullet\mathbf{n}=(-0.1392-1.0868)\bullet\mathbf{F}\bullet\mathbf{n}=-1.226*96485*24=\mathbf{-2840}\ ^{kJ}/_{mol}\ \text{and}$$

$$\Delta \mathbf{G}_{Homeostasis}=\Delta \mathbf{E}\bullet\mathbf{F}\bullet\mathbf{n}=(\mathbf{E}_{C6H12O6}-\mathbf{E}_{O2})\bullet\mathbf{F}\bullet\mathbf{n}=(\mathbf{-0.88427}-0.4349)\bullet\mathbf{F}\bullet\mathbf{n}=-1.31917*96485*24=\mathbf{-3054.7}\ ^{kJ}/_{mol}.$$

The oxygen reduction: $6*(O_{2aqua}+4H_3O^++4e^-=6H_2O;)$ **inverse** standard potential $E^\circ_{O2}=\mathbf{1.0868}$ Volts and glucose Homeostasis constant with attractors $[H_3O^+]=10^{-7.36}$ M, $[HCO_3^-]=\mathbf{0.0154}$ M, $/[C_6H_{12}O_6]=5*10^{-3}$ M , water $[H_2O]=55.3$ M and $\Delta \mathbf{G}_{Lehninger}=-2840\ ^{kJ}/_{mol}$ is greater about one $K_{eqHomeostasis}=10^{\wedge 498}{}_t$:

$$K_{eqHomeostasis}=\frac{[HCO_3^-]^6[H_3O^+]^6}{[C_6H_{12}O_6]\cdot[O_2]^6[H_2O]^6}=EXP(-\Delta \mathbf{G}_{eqHomeostasis}/R/T)=EXP(\mathbf{2840000}/8.3144/298.15=10^{\wedge 498}:$$

Quasi state equilibrium driven irreversibly which as engine of photosynthesis accumulates free energy in products: $6H_3O^++6HCO_3=\text{Photosynthesis}=>C_6H_{12}O_6+6O_{2aqua}+6H_2O$; $\Delta \mathbf{G}_{Lehninger}=2840\ ^{kJ}/_{mol}$ .

$$\text{Hess law } 2840\ ^{kJ}/_{mol}=\mathbf{G}_{C6H12O6}+\mathbf{6*}G_{O2Homeostasis\_arterial}+\mathbf{6*}G_{H2O\_Biochem}-(6*G_{H3O+}+6*G_{HCO3-})$$

free energy content of one mol glucose is calculated referring Alberty data. [8,15]

Formation from elements $S_{rhombic}+\mathbf{H}_{2gas}=\mathbf{H_2S}_{gas}$ shows energy content in one mol $G_{S\,rhombic}=\mathbf{-85.64}$ kJ/mol; [1,6]

Formation energy change is $\Delta G_{Hess\_\mathbf{H2S}gas}=G°_{\mathbf{H2S}gas}-({}_{\mathbf{Hess}}G°_{Srombisks}+{}_{\mathbf{Hess}}G°_{\mathbf{H2}})=-20.6-(\mathbf{0}+0)=-20.6$ kJ/mol. [1]

Sulfur energy content in mol is $G_{Srombisks}=G°_{\mathbf{H2S}as}-(\Delta G_{Hess\_\mathbf{H2S}gas}+G°_{\mathbf{H2}gas})=-20.6-(-20.6+\underline{\mathbf{85.64}})=\mathbf{-85.64}$ kJ/mol;

Free energy content hydrogen sulfide aqua $G_{\mathbf{H2S}aqua}=\mathbf{-30.82}$ kJ/mol. [1,6]

Nernst's reduction of sulfur half reaction $\mathbf{H_2S}_{aq}+2H_2\mathbf{O}=S_{rhombic}+2\mathbf{H_3O}^++2e^-$; has absolute standard potential $\mathbf{E°^1_{H2S}=}-0.0515$ V for free energy change: $\Delta \mathbf{G_{eqH2S}=E°^1_{H2S}Fn=}-0.0515*96485*2=\mathbf{-9.938}$ kJ/mol . It shows free energy content of in one mole $G_{\mathbf{H2S}aqua}=\mathbf{-30.82}$ kJ/mol as expression from Hess law for free energy change in half reaction $\Delta G_{Hess\_\mathbf{H2S}aq}=G_{Srhombic}+2G_{\mathbf{H3O}+}-(G_{\ \mathbf{H2S}aq}\mathbf{+2}G_{\mathbf{H2O}})=\mathbf{-85.64}+2*\mathbf{22.44}-(G_{\ \mathbf{H2S}aq}+2*0)=\mathbf{-9.938}$ kJ/mol to hydrogen sulfide aqua solution:

$$G_{\ \mathbf{H2S}aq}=G_{Srhombic}+2G_{\mathbf{H3O}+}-(\Delta G_{Hess\_\mathbf{H2S}aq}\mathbf{+2}G_{\mathbf{H2O}})=\mathbf{-85.64}+2*\mathbf{22.44}-(\mathbf{-9.938}+2*0)=\mathbf{-30.82}\ \text{kJ/mol}.$$

Sulfur **inverse** half reaction $S_{rhombic}+2\mathbf{H_3O}^++2e^-=\mathbf{H_2S}_{aq}+2H_2\mathbf{O}$; $\mathbf{-E°^1_{H2S}}=0.0515$ Volts with two metallic hydrogen moles half reactions $\underline{2(Pt)H}+2H_2O=2H_3O^++4e^-$; $E°_H=-0.2965$ V absolute standard potentials sum is:

$$\Delta E°_{Red\text{-}Ox}=(E°_H\mathbf{-E°^1_{H2S}})=(-0.2965+0.0515)=-0.245\ \text{Volts}\ .$$

Metal hydrogen $\underline{(Pt)H}$ reduce rhombic sulfur : $S_{rhombic}+\underline{2(Pt)H}=H_2S_{aq}$; about hydrogen sulfide.

Free energy change minimum for equilibrium state of metal hydrogen $\underline{(Pt)H}$ oxidation with sulfur :is negative:

$$\Delta \mathbf{G_{eq}}=(E°_H\mathbf{-E°^1_{H2S}})\bullet F\bullet 1\bullet 2=(-0.2965+0.0515)*96485*2=-0.245*96485*2/1000=\mathbf{-47.28}\ \text{kJ/mol}.\ ;\text{CRC [1]}$$

Expressing from Hess law of free energy change:

$$\Delta G_{\mathbf{HessH2S}}=G_{\mathbf{H2S}aqua}-(2G_{\mathbf{H(Pt)}}+G_{Srhombic})=G_{\mathbf{H2S}aqua}-(2*\mathbf{51.05-85.64})=\mathbf{-47.28}\ \text{kJ/mol shows}$$

the hydrogen sulfide aqua identical negative energy content $G_{\mathbf{H2S}aqua}=\mathbf{-30.82}$ kJ/mol as for half reaction alone:

$$G_{\mathbf{H2S}aqua}=\Delta G_{\mathbf{HessH2S}}+(2G_{\mathbf{H(Pt)}}+G_{Srhombic})=\mathbf{-47.28}+(2*\mathbf{51.05-85.64})=\mathbf{-30.82}\ \text{kJ/mol}\ .$$

Alberty based data are coincident with absolute standard potential scale in both half reactions as alone $\mathbf{E°^1_{H2S}=}-0.0515$ V and so in coupled oxidation - reduction complete reactions with **absolute** plus **inverse** standard potential sum like

$$\Delta E°_{Red\text{-}Ox}=(E°_H\mathbf{-E°^1_{H2S}})=(\mathbf{-0.2965}+0.0515)=-0.245\ \text{Volts}.$$

Discovery of Hydrogen electrode reference $E°_H$= -0.2965 Volts in **absolute potential scale**
synchronizes the sciences with **absolute scale** of free energy.

Discovery of Hydrogen electrode reference point $E°_H$= -0.2965 V for **absolute** potential and **absolute** free energy **scale** with **inverted** symmetry meaning of half reaction for which **inverse** potential belongs the same number with the opposite sign as symmetry coincides with the **inverted absolute** free energy, the same number with the opposite sign.

**Absolute** and **inverse** free energy and potential **scale** require water and hydroxonium accounting based on Alberty data of hydrogen gas and solution thermodynamic **absolute** free energy.

**Absolute** Free Energy scale requires to metabolites applied zero background reference to water and carbon dioxide gas as shown in Figure 1..

**Inversion** symmetry which is applied by mutual coincidence as Thermodynamic tools: the **Absolute** Free Energy and the **Absolute Potentials scale** for revealing the structural details of Nernst's half, **inverse** and full oxidation–reduction reactions.

**Hess zero standard values** of **elements** actually are positive Biochemistry energies.
$G_{H2gas}$=**85.6** $^{kJ}/_{mol}$ Alberty referring to homeostasis products water and **CO**$_{2gas}$ zero $G_{H2O}=G_{CO2gas}=0$ $^{kJ}/_{mol}$ .
Some reactants [1,8] free energy content applied to homeostasis products zero values scale are:
Glucose $G_{C6H12O6}$=2268.8 $^{kJ}/_{mol}$ >deprotonate peroxide anion $G_{HOO-}$=**338** $^{kJ}/_{mol}$ > $G_{O2aqua}$=330 $^{kJ}/_{mol}$>
> $G_{O2gas}$=303 $^{kJ}/_{mol}$> peroxide $G_{H2O2}$=284 $^{kJ}/_{mol}$>$G_{NH4+}$=**232.9** $^{kJ}/_{mol}$>
>protolysis of water pH=pOH=7 $G_{H3O++OH-}=G_{H3O+}+G_{OH}$=22.44+77.36=99.8 $^{kJ}/_{mol}$>
> $G_{NH3aq}$=**91.1** $^{kJ}/_{mol}$ >$G_{H2gas}$=**85.6** $^{kJ}/_{mol}$ ≡ $G_{H2O\_Biochemistry}$=**85.6** $^{kJ}/_{mol}$ > $G_{O2Biochem\_arterial}$=78.1 $^{kJ}/_{mol}$ >
>protolysis of **CO**$_{2aqua}$ solution by Carbonic Anhydrase $G_{H3O+HCO3}=G_{H3O+}+G_{HCO3-}$=22.44+46.08=68.5 $^{kJ}/_{mol}$ >
> $G_{H(Pt)}$=**51** $^{kJ}/_{mol}$ > $G_{N2aqua}$=**18.7** $^{kJ}/_{mol}$ > homeostasis products zero values $G_{H2O}=G_{CO2gas}=0$ $^{kJ}/_{mol}$ >
>$G_{H2Saqua}$=**-30.82** $^{kJ}/_{mol}$ > $G_{Srhombic}$=**-85.64** $^{kJ}/_{mol}$ ;

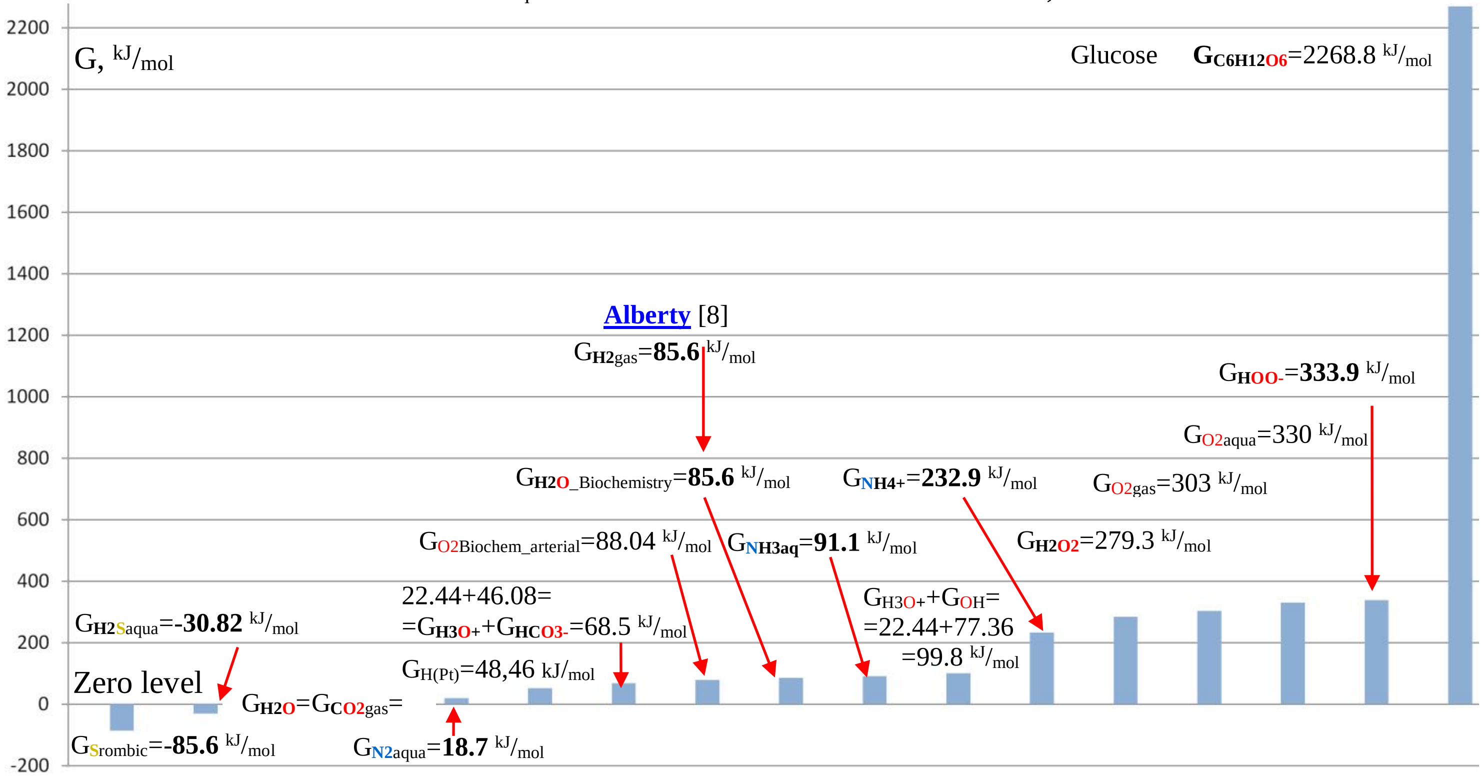


Figure 1. Ascending **Absolute** Free Energy of metabolites relative to $G_{H2O}=G_{CO2gas}=0$ $^{kJ}/_{mol}$ zero values.
Discovery of **Absolute potential scale** is instrument coincident with **Absolute** Free Energy for sciences.
The discovery in science of **Absolute Potentials scale** coincides with **Absolute** Free Energy meaning.

The water and hydroxonium disaccount in reactions including protolysis and electrochemistry Nernst's half reactions restrict the scientific studies of Thermodynamic, Physical Chemistry and Biochemistry. [8,14,15]

The thermodynamic property of **inversion** symmetry is a direct reaction between reactants and products that flips in the opposite direction, initially meaning products as reactants and leaving reactants as final products. Water to oxygen oxidation reduction **$6H_2O=O_{2aqua}+4H_3O^++4e^-$** Nernst's half reaction has **Absolute** standard **Potential**: $E^\circ_{O2Absolute}$=1.0868 V. About **$O_{2aqua}+4H_3O^++4e^-=6H_2O$** **inverse** reaction implication in **Absolute Potential** it has the same number with opposite sign $-E^\circ_{O2Absolute}$= -1.0868 V negative.

Discovered the **Absolute Potential scale** for Nernst's or **inverse** reactions is coincident with **absolute** Free Energy property the **inverse** symmetry. [8, 14, 15] **Inverse symmetry** property of Nernst's or **inverse** reactions with **identical values** but with **opposite sign** manifests itself mutually in **Absolute Potential scale** with **Absolute** Free Energy is coincident thermodynamic property for protolytic, Nernst's half or **inverse** reaction.

Corrected Thermodynamic standard potential reference of metal hydrogen 0.10166 Volts in few years give the impulse for sciences get **Absolute** thermodynamic values Free Energy of elements and molecules. Behalf of Alberty given data about Hydrogen **Absolute** Free Energy $G_{H2gas}$=**85.6** $^{kJ}/_{mol}$ , $G_{H2aqua}$=**103** $^{kJ}/_{mol}$ is detected **Absolute** standard **Potential** as general reference of hydrogen electrode $E^\circ_H$=-0.2965 Volts. Table 1. presents 50 in Biochemistry used Nernst's oxidation half and reduction **inverse** reactions.

In three columns we can observe the development hydrogen general reference scale from classic zero $E^\circ_H$=0 V with water disaccount. Accounting the water and hydroxonium cation corrected the general hydrogen thermodynamic standard potential scale reference to $E^\circ_H$=0.10166 Volts. Third Alberty data finally lead to **Absolute** standard **Potential** value $E^\circ_H$=-0.29654 Volts of hydrogen electrode.

$H_2O_2$ formation 41st page $H_{2gas}+O_{2gas}\Rightarrow H_2O_2$ ; $\Delta G^{\circ}_{\text{UnivAlberta}}=-134.03\ ^{kJ}/_{mol}$ ; $\Delta G^{\circ}_{\text{Alberty}}=\mathbf{-48.39}\ ^{kJ}/_{mol}$ ;
$\Delta G_{\text{Alberty}}=G_{H2O2}-(G_{O2gas}+G_{H2gas})=\underline{\mathbf{284-(85.64+303}}\mathbf{)=-104.64}\ ^{kJ}/_{mol}(-134.03\ ^{kJ}/_{mol};)(=\mathbf{-48.39}\ ^{kJ}/_{mol})$

| *Viela* | $\Delta H^{\circ}_{H}\ ^{kJ}/_{mol}$ | $\Delta S^{\circ}_{H}\ ^{J}/_{mol/K}$ | $\Delta G^{\circ}_{H}\ ^{kJ}/_{mol}$ |
|---|---|---|---|
| $H_2O_{2aqua}$ | **-191.99** | **-481.688** | **-48.39** |
| $H_2O_{2aqua}$ | -191.17 | 143.9 | -134.03 |
| **Succinat$^{2-}$** | **-908.69** | **-1295.576** | **-522.414** |
| **Fumarate$^{2-}$** | **-776.56** | **-862.288** | **-519.4688** |

$\underline{G_{H2O2}=\mathbf{279{,}29}}\ ^{kJ}/_{mo}$ Alberty zero $G_{H2O}=\mathbf{0}\ ^{kJ}/_{mol}$; reference based University Alberta

$G_{\text{SuccinatFor}}=-522.4+(4*91.26+2*85.6+2*303)=\mathbf{619.8}\ ^{kJ}/_{mol}$; $G_{\text{Succinat}}=\mathbf{650.8}\ ^{kJ}/_{mol}$;

$G_{\text{FumaricFor}}=-519.5+(4*91.26+85.6+2*303)=\mathbf{537.1}\ ^{kJ}/_{mol}$; $G_{\text{Fumarat}}=\mathbf{554.75}\ ^{kJ}/_{mol}$;

**Succinat$^{2-}$** Formation $4C+2H_{2gas}+2O_{2gas}\Rightarrow(CH_2)_2(CO_2^-)(CO_2^-)$ ; $\Delta G_{\text{Succinat}}=\mathbf{-522.4}\ ^{kJ}/_{mol}$ Alberty;
$\Delta G_{\text{SuccinatFor}}=G_{\text{SuccinatFor}}-(4G_{\text{Cgraph}}+2*G_{H2gas}+2*G_{O2gas})=\mathbf{-522.4}\ ^{kJ}/_{mol}$;
$G_{\text{SuccinatFor}}=\mathbf{-522.4+(4*91.26+2*85.6+2*303)=619.8}\ ^{kJ}/_{mol}$;

**Fumarate$^{2-}$** Formation $4C+H_{2gas}+2O_{2gas}\Rightarrow(CH)_2(CO_2^-)(CO_2^-)$ ; $\Delta G_{\text{Fumarat}}=\mathbf{-519.5}\ ^{kJ}/_{mol}$ Alberty;
$\Delta G_{\text{Fumarat}}=G_{\text{FumaratFor}}-(4G_{\text{Cgraph}}+G_{H2gas}+2*G_{O2gas})=\mathbf{-519.5}\ ^{kJ}/_{mol}$;
$G_{\text{FumaratFor}}=\mathbf{-519.5+(4*91.26+85.6+2*303)=537.1}\ ^{kJ}/_{mol}$ ; formation 73rd page

**Inverse** $O_{2aqua}+2H_3O^++2e^-=H_2O_{2aqua}+2H_2O$; standard potential $E^{\circ}_{\text{OxO2\_H2O2}}=-0.5278$ V University Alberta ;
$\Delta G_{\text{AlbertyHessOxO2\_H2O2}}=G_{H2O2}+2*G_{H2O}-(G_{O2aqua}+2*G_{H3O+})=\underline{\mathbf{279{,}29+2*0-(330+2*22.44)}}\mathbf{=-95.59}\ ^{kJ}/_{mol}$ ;
$\Delta G_{\text{eqAlbertyAbsoluteOxO2\_H2O2}}=E^{\circ}_{\text{eqOxO2\_H2O2}}\bullet F\bullet 1\bullet 2=\mathbf{-0.}5278*96485*2=\mathbf{-101{,}85}\ ^{kJ}/_{mol}$;

**Succinat$^{2-}$+$O_{2aqua}\Rightarrow$fumarate$^{2-}$+$H_2O_{2aqua}$+Q+$\Delta$G**; $\Delta G_{\text{min}}=\Delta G_{\text{eqSuccinat\_ H2O2}}=\mathbf{-38.3}\ ^{kJ}/_{mol}$;
$\Delta G_{\text{Hess}}=\Delta G^{\circ}_{H2O2}+\Delta G^{\circ}_{\text{fumarat}}-\Delta G^{\circ}_{O2}-\Delta G^{\circ}_{\text{Succinat}}=\mathbf{-48.39-519.4688-(16.4-522.414)}=\mathbf{-61.845}\ ^{kJ}/_{mol}$;
$\Delta G_{\text{min}}=\Delta G_{\text{eq}}=(E^{\circ}_{\text{RedSuccinate}}-E^{\circ}_{\text{OxO2}})*F*n=(0.2512-0.4495)*96485*2=(-0.1983)*96485*2=\mathbf{-38.3}\ ^{kJ}/_{mol}$;
Alberty Hess $\Delta G_{\text{Succinat\_ H2O2}}=G_{\text{Fumarat}}+G_{H2O2}-(G_{\text{Succinat}}+G_{O2aqua})=\mathbf{537.1+279{,}29.24-(619.8+330)=-128.5}\ ^{kJ}/_{mol}$ ;
$\mathbf{K_{eq}=exp(-\Delta G_{eq}/R/T)}=exp(\mathbf{38270}/8.3144/298.15)=5065991$ spontaneous 58th page

The concepts of **Absolute** thermodynamic parameters temperature, free energy and potentia. are **absolutely** reciprocal tools for revealing the structural details of parallel and sequential complex reactions by exploiting inversion symmetry properties.

**1. Absolute** temperature T in Kelwin degree is standard value 298.15 K (25 ° C),

Lord Kelvin

**2.** On Alberty based **Absolute** free energy content

$G_{H2gas}=\mathbf{85.6}\ ^{kJ}/_{mol}$ for hydrogen gas, it's solution in water $G_{H2aqua}=\mathbf{103}\ ^{kJ}/_{mol}$ and

for metal hydrogen $G_{H(Pt)}=\mathbf{48{,}46}\ ^{kJ}/_{mol}$

referring to zero reference $G_{H2O}=G_{CO2gas}=0\ ^{kJ}/_{mol}$ as background

in water and carbon dioxide gas $\mathbf{CO_{2gas}}$.

Alberty Robert

**3.** Discovery **Absolute Potential** scale.
**Absolute Potential** scale based on a general reference
of metal hydrogen **Absolute** standard **Potential** $E^{\circ}_{H}=-0.2965$ Volts. [8, 14, 15]

feasible

$\mathbf{CH_3CH_2OH}$ ethanol formation from elements:

$2C+3H_{2gas}+1/2O_{2gas}=>CH_3CH_2OH$ ; $\Delta G^\circ_{Alberty}=\mathbf{75.2864}\ ^{kJ}/_{mol}$ ; $\Delta G^\circ_{HessCRC}=-181\ ^{kJ}/_{mol}$ ;

$\Delta G^\circ_{Alberty}=G_{CH3CH2OH}-(2G_{Cgraph}+3*G_{H2gas}+1/2*G_{O2gas})=75.2864\ ^{kJ}/_{mol}$ ;

$\Delta G^\circ_{CRC}=G_{CH3CH2OH}-(2G_{Cgraph}+3*G_{H2gas}+1/2*G_{O2gas})=-181\ ^{kJ}/_{mol}$ ;

$\Delta G^\circ_{Alberty}+(2G_{Cgraph}+3*G_{H2gas}+1/2*G_{O2gas})=75.2864+(2*91.26+3*85.6+1/2*303)=G_{CH3CH2OH}=666.106\ ^{kJ}/_{mol}$ ;

$\Delta G^\circ_{CRC}+(2G_{Cgraph}+3*G_{H2gas}+1/2*G_{O2gas})=-181+(2*91.26+3*85.6+1/2*303)=G_{CH3CH2OH}=409.82\ ^{kJ}/_{mol}$ ;

$\mathbf{CH_3CHO}$ acetaldehyde formation from elements: $2C+2H_{2gas}+1/2O_{2gas}=>CH_3CHO$ ;

$\Delta G^\circ_{Alberty}=G_{CH3CHO}-(2G_{Cgraph}+2*G_{H2gas}+1/2*G_{O2gas})=32.282\ ^{kJ}/_{mol}$ ;

$\Delta G^\circ_{CRC}=G_{CH3CHO}-(2G_{Cgraph}+2*G_{H2gas}+1/2*G_{O2gas})=24.06\ ^{kJ}/_{mol}$ ;

$\Delta G^\circ_{Alberty}+(2G_{Cgraph}+2*G_{H2gas}+1/2*G_{O2gas})=32.282+(2*91.26+2*85.6+1/2*303)=G_{CH3CHO}=537.5\ ^{kJ}/_{mol}$ ;

$\Delta G^\circ_{CRC}+(2G_{Cgraph}+2*G_{H2gas}+1/2*G_{O2gas})=24.06+(2*91.26+2*85.6+1/2*303)=G_{CH3CHO}=529.28\ ^{kJ}/_{mol}$ ;

$\mathbf{CH_3CH_2OH+H_2O=CH_3CHO+H_3O^++H^-(H^++2e^-)}$; absolute potential $E^\circ_{CH3CH2OH}=-0.055$ V; Kortly, Shucha; [19]

$\Delta G_{eqCH3CH2OH}=E^\circ_{eqNernsCH3CH2OH}\bullet F\bullet 2=-0.055*96485*2=-10.6\ ^{kJ}/_{mol}$;

$\Delta G_{HessCH3CH2OH}=G_{CH3CHO}+G_{H3O+}+G_{H-}-(G_{CH3CH2OH}+G_{H2O})=537.5+22.44+G_{H-}-(409.82+0)=-10.6\ ^{kJ}/_{mol}$.

$\Delta G_{HessCH3CH2OH}=G_{CH3CHO}+G_{H3O+}+G_{H-}-(G_{CH3CH2OH}+G_{H2O\_Biochem})=537.5+22.44+G_{H-}-(409.82+85.64)=-10.6\ ^{kJ}/_{mol}$.

$\Delta G_{HessCH3CH2OH}-G_{CH3CHO}-G_{H3O+}+(G_{CH3CH2OH}+G_{H2O})=G_{H-}=-10.6-537.5-22.44+(409.82+0)=-160.7\ ^{kJ}/_{mol}$.

$\Delta G_{HessCH3CH2OH}-G_{CH3CHO}-G_{H3O+}+(G_{CH3CH2OH}+G_{H2O\_Biochem})=G_{H-}=-10.6-537.5-22.44+(409.82+85.64)=-75.08\ ^{kJ}/_{mol}$.

| *Substance* | $\Delta H^\circ_H\ ^{kJ}/_{mol}$ | $\Delta S^\circ_H\ ^{J}/_{mol/K}$ | $\Delta G^\circ_H\ ^{kJ}/_{mol}$ |
|---|---|---|---|
| $\mathbf{H_3C\text{-}CH{=}O}$ | -212.23 | -281.84 | 24.06 |
| $\mathbf{H_3C\text{-}CH{=}O}$ | **-213.88** | **-825.64** | **32.2824** |
| **NADH** | **-41.41** | **-4465.708** | **1175.5732** |
| **NADH** | -1036.66 | -140.50 | 1120.09 |
| $\mathbf{H_3O^+}$ | -285.81 | -3.854 | -213.275 |
| $NAD^+$ | **-10.30** | **-3766.008** | **1112.534** |
| $NAD^+$ | -1007.48 | -183 | 1059.11 |
| $\mathbf{H_3CCH_2OH}$ | **-290.77** | **-1227.764** | **75.2864** |
| $H_3CCH_2OH_{aq}$ | -288.3 | -357.7394 | -181.64 |
| $\mathbf{H_2O}$ | -285.85 | 69.9565 | -237.191 |
| $\mathbf{H_2O}$ | **-286.65** | **-453.188** | **-151.549** |

CRC Handbook of Chemistry and Physics 2010 90th David R. Lide

$G_{CH3CHO}=529.28\ ^{kJ}/_{mol}$ ;

$G_{CH3CHO}=537.5\ ^{kJ}/_{mol}$ ;

BioThermodynamic06;

BioThermodynamic,2006,Massachusetts Tecnology Institute,Alberty

Alberty $G_{CH3CH2OH}=666.106\ ^{kJ}/_{mol}$ ;

CRC $G_{CH3CH2OH}=409.82\ ^{kJ}/_{mol}$ ;

$G_{H2O}=0\ ^{kJ}/_{mol}$; $G_{H-}=-10.6-537.5-22.44+(409.82+0)=-160.7\ ^{kJ}/_{mol}$.

$G_{H2O\_Biochem}=85.64\ ^{kJ}/_{mol}$. $G_{H-}=-10.6-537.5-22.44+(409.82+85.64)=-75.08\ ^{kJ}/_{mol}$

$\mathbf{NADH = NAD^+ + H^-(H^++2e^-)}$; inverse potential $-E^\circ_{NADH}=0.4095$ V; absolute David Harris; [22]

$\mathbf{NAD^+}$+~~$\mathbf{H^-(H^++2e^-)}$~~+$\mathbf{CH_3CH_2OH+H_2O=NADH+CH_3CHO+H_3O^+}$+~~$\mathbf{H^-(H^++2e^-)}$~~;

$\mathbf{NAD^++CH_3CH_2OH+H_2O=NADH+CH_3CHO+H_3O^+}$;

sum: $E^\circ_{eqNernsCH3CH2OH}-E^\circ_{NAD+}=-0,055+0,4095=\mathbf{0,4562}$;

$\Delta G_{min}=\Delta G_{eq}=(E^\circ_{eqNernsCH3CH2OH}-E^\circ_{NAD+})*F*n=(-0.055+0.4095)*96485*2=(0.4562)*96485*2=68.408\ ^{kJ}/_{mol}$;

$\Delta G_{HessAlbertyCH3CH2OH}=G_{NADH}+G_{H3O+}+G_{CH3CHO}-(G_{NAD+}+G_{CH3CH2OH}+G_{H2O})=68.02\ ^{kJ}/_{mol}$.

$=1112.534+22.44+32.282-(1175.5+75.2864-151.549)=68.02\ ^{kJ}/_{mol}$.

$H_3CHC(OH)COO^- + \mathbf{H_2O} => H_3CC{=}OCOO^- + \mathbf{H_3O^+} + \mathbf{H^-(H^+ + 2e^-)}$; $\mathbf{E°}_{H3CHC(OH)COO} = -0.0159$ V;

$\Delta \mathbf{G}_{\mathbf{eq}H3CHC(OH)COO} = \mathbf{E°}_{\mathbf{eq}H3CHC(OH)COO} \bullet F \bullet 2 = \mathbf{-0.}0159*96485*2 = \mathbf{-3.068}\ ^{kJ}/_{mol}$;

$\Delta \mathbf{G}_{\mathbf{HessCH3CH2OH}} = \mathbf{G}_{H3CC=OCOO} + G_{H3O+} + G_{H-} - (\mathbf{G}_{H3CHC(OH)COO} + \mathbf{G}_{\mathbf{H2O}}) = \mathbf{534.2 + 22.44} + G_{H-} - (\mathbf{668.8} + 0) = \mathbf{-3.068}\ ^{kJ}/_{mol}$.

$\Delta \mathbf{G}_{\mathbf{HessCH3CH2OH}} = \mathbf{G}_{H3CC=OCOO} + G_{H3O+} + G_{H-} - (\mathbf{G}_{H3CHC(OH)COO} + \mathbf{G}_{\mathbf{H2O}\_Biochem}) = \mathbf{534.2 + 22.44} + G_{H-} - (\mathbf{668.8 + 85.64}) = \mathbf{-3.068}\ ^{kJ}/_{mol}$.

$\Delta \mathbf{G}_{\mathbf{HessCH3CH2OH}} - \mathbf{G}_{H3CC=OCOO} - G_{H3O+} + (\mathbf{G}_{H3CHC(OH)COO} + \mathbf{G}_{\mathbf{H2O}}) = G_{H-} = \mathbf{-3.068 - 534.2 - 22.44 + (668.8} + 0\mathbf{) = 109.092}\ ^{kJ}/_{mol}$.

$\Delta \mathbf{G}_{\mathbf{HessCH3CH2OH}} - \mathbf{G}_{H3CC=OCOO} - G_{H3O+} + (\mathbf{G}_{H3CHC(OH)COO} + \mathbf{G}_{\mathbf{H2O}\_Biochem}) = G_{H-} = \mathbf{-3.068 - 534.2 - 22.44 + (668.8 + 85.64) = 194.7}\ ^{kJ}/_{mol}$.

I=0.25 M, **BioTherm06**, pH=7.36, $\Delta G_H = G°_{H3CC=OCOO-} + G°_{\mathbf{H3O+}} + G_{H-} - G_{H3CHC(OH)COO-} - G_{\mathbf{H2O}} =\ ^{kJ}/_{mol}$;

*Viela* $\Delta H°_H\ ^{kJ}/_{mol}$ $\Delta S°_H\ ^{J}/_{mol/K}$ $\Delta G°_H$ , $^{kJ}/_{mol}$ ;

| | | | |
|---|---|---|---|
| **PyruvEnolP$^{3-}$** | -1400 | -1100 | -1189.73 |
| $H_3CC{=}OCOO^-$ | -597.4 | -850 | -350.78 |
| $H_3CC{=}OCOO^-$ | -603.7 | -433.54 | -474.44 |
| $H_3CC{=}OCOO^-$ | **-597.04** | **-846.66** | **-344.62** |
| **$H_3O^+$** | -285.81 | -3.854 | -213.275 |
| **$H_2O$** | -285.85 | 69.9565 | -237.191 |
| **$H_2O$** | **-286.65** | **-453.188** | **-151.549** |
| $H_3CHC(OH)COO^-$ | **-688.29** | **-1290.9** | **-303.4** |

$G_{\mathbf{H2O}} = \mathbf{0}\ ^{kJ}/_{mol}$; $G_{H-} = \mathbf{-3.068 - 534.2 - 22.44 + (668.8} + 0\mathbf{) = 109.092}\ ^{kJ}/_{mol}$

$G_{\mathbf{H2O}\_Biochem} = \mathbf{85.64}\ ^{kJ}/_{mol}$; $G_H = \mathbf{-3.068 - 534.2 - 22.44 + (668.8 + 85.64) = 194.7}\ ^{kJ}/_{mol}$

$G_{H3CHC(OH)COO} = \mathbf{534.2}\ ^{kJ}/_{mol}$; $pK_a = 2.5$;

$G_{H3CHC(OH)COO} = \mathbf{668.8}\ ^{kJ}/_{mol}$; $pK_a = 3.86$;

$\mathbf{pK_a} = 3.86$; $\Delta H_c° = 1361.9\ ^{kJ}/_{mol}$; $G_{H3CHC(OH)COOH} = \mathbf{2271}\ ^{kJ}/_{mol}$; $H_3CHC(OH)COOH + 3\mathbf{O_2}_{gas} = 3C\mathbf{O_2}_{gas} + 3\mathbf{H_2O}$;

$\Delta H_c° = 3G_{C\mathbf{O2}gas} + 3G_{H2O} - (G_{H3CHC(OH)COOH} + 3G_{\mathbf{O2}gas}) = 3*\mathbf{0} + 3*\mathbf{0} - (G_{H3CHC(OH)COOH} + 3\mathbf{*303}) = 1361.9\ ^{kJ}/_{mol}$;

$G_{H3CHC(OH)COOH} + = 3G_{C\mathbf{O2}gas} + 3G_{H2O} - (3G_{\mathbf{O2}gas}) = 3*\mathbf{0} + 3*\mathbf{0} - (+3\mathbf{*303}) - 1361.9 = G_{H3CHC(OH)COOH} = \mathbf{2271}\ ^{kJ}/_{mol}$;

**Lactic acid** Formation 71st page $3\mathbf{C} + 3\mathbf{H_{2gas}} + 1.5\mathbf{O_2}_{gas} => H_3CHC(OH)COOH$ ; $G_{H3CHC(OH)COOH} = \mathbf{-303.4}\ ^{kJ}/_{mol}$ [8];

$\Delta G_{H3CHC(OH)COOH} = G_{H3CHC(OH)COOH} - (\mathbf{3G_{C}}_{graph} + \mathbf{3*G_{H2}}_{gas} + \mathbf{1.5*}G_{O2gas}) = \mathbf{-303.4}\ ^{kJ}/_{mol}$;

$G_{H3CHC(OH)COOH} = \mathbf{-303.4 + (3*91.26 + 3*85.6 + 1.5*303) = 681.7}\ ^{kJ}/_{mol}$;

Lactic acid $H_3CHC(OH)COOH + \mathbf{H_2O} <=> H_3CHC(OH)COO^- + H_3O^+$; $pK_a = 3.86$;

$K_{eq} = [H_3CHC(OH)COO^-]*[H_3O^+]/[H_3CHC(OH)COOH]/[\mathbf{H_2O}] = K_a/[\mathbf{H_2O}] = 10^{\wedge(-3.86)}/55.3 = 2.5*10^{\wedge(-6)} = 10^{\wedge(-5.603)}$;

$\Delta \mathbf{G}_{\mathbf{eq}H3CHC(OH)COOH} = -R \bullet T \bullet \ln(\mathbf{K_{aeq}}) = -8.3144*298.15*\ln(10^{\wedge(-5.603)})/1000 = \mathbf{31.98}\ ^{kJ}/_{mol}$ .

$\Delta G_{H3CHC(OH)COO} = G_{H3CHC(OH)COO} + 2G_{H3O+} - (G_{\mathbf{LacticAc}} + 2G_{H2O}) = G_{\mathbf{Succinat}} + \mathbf{2*22.44 - (681.7 + 2*0) = 31.98}\ ^{kJ}/_{mol}$;

$G_{H3CHC(OH)COO} = \Delta G_{H3CHC(OH)COO} - 2G_{H3O+} + (G_{\mathbf{LacticAc}} + 2G_{H2O}) = \mathbf{31.98 - 2*22.44 + (681.7 + 2*0) = 668.8}\ ^{kJ}/_{mol}$;

**Pyruvic acid$^-$** Formation 71st page $3\mathbf{C} + 2\mathbf{H_{2gas}} + 1.5\mathbf{O_2}_{gas} => H_3CC{=}OCOOH$; $\Delta G_{\mathbf{Succinat}} = \mathbf{-344.62}\ ^{kJ}/_{mol}$ Alberty;

$\Delta G_{\mathbf{Fumarat}} = G_{\mathbf{Fumarat}} - (\mathbf{3G_{C}}_{graph} + 2G_{\mathbf{H2}gas} + \mathbf{1.5*}G_{O2gas}) = \mathbf{-344.62}\ ^{kJ}/_{mol}$;

$G_{\mathbf{Fumarat}} = \mathbf{-344.62} + \mathbf{(3*91.26} + 2\mathbf{*85.6 + 1.5*303) = 554.86}\ ^{kJ}/_{mol}$; ;

**Pyruvic acid** $H_3CC{=}OCOOH + \mathbf{H_2O} <=> H_3CHC(OH)COO^- + H_3O^+$; $pK_a = 2.5$;

$K_{eq} = [H_3CHC(OH)COO^-]*[H_3O^+]/[H_3CC{=}OCOOH]/[\mathbf{H_2O}] = K_a/[\mathbf{H_2O}] = 10^{\wedge(-2.5)}/55.3 = 2.5*10^{\wedge(-6)} = 10^{\wedge(-4.243)}$;

$\Delta \mathbf{G}_{\mathbf{eq}H3CC=OCOOH} = -R \bullet T \bullet \ln(\mathbf{K_{aeq}}) = -8.3144*298.15*\ln(10^{\wedge(-4.243)})/1000 = \mathbf{24.22}\ ^{kJ}/_{mol}$ .

$\Delta G_{H3CHC(OH)COO} = G_{H3CHC(OH)COO} + 2G_{H3O+} - (G_{\mathbf{LacticAc}} + 2G_{H2O}) = G_{\mathbf{Succinat}} + \mathbf{2*22.44 - (554.86 + 2*0) = 24.22}\ ^{kJ}/_{mol}$;

$G_{H3CHC(OH)COO} = \Delta G_{H3CHC(OH)COO} - 2G_{H3O+} + (G_{\mathbf{LacticAc}} + 2G_{H2O}) = \mathbf{24.22 - 2*22.44 + (554.86 + 2*0) = 534.2}\ ^{kJ}/_{mol}$;

**NADH = NAD$^+$ + H$^-$(H$^+$+2e$^-$)**; **E°**$_{\mathbf{NADH}}$=-0.4095 V; absolute Lehninger; [6]$^-$

**Red** **lactate$^-$+H$_2$O<=>pyruvate$^-$+H$_3$O$^+$+H$^-$( H$^+$+2e$^-$)** ; absolute potential **E°**$_{H3CHC(OH)COO}$=-0.0159 V;

**Ox** **NAD$^+$+H$^-$(2e$^-$)=NADH** ; **E°$^1$=-0.4095 V;** OksRed **NAD$^+$+lactate$^-$+H$_2$O=NADH+ pyruvate$^-$+H$_3$O$^+$**;

Balanced **n=2=m** with **2e$^-$** electrons ΔE° **NAD$^+$** **accept** electrons from **lactate**:

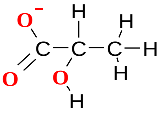
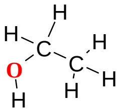
$$\Delta \mathbf{G}_{\mathbf{eq}Aerobic} = \mathbf{\Delta E° \bullet F \bullet n = (E°_{Red} - E°_{Ox})*F*n} = (-0.0159 — \mathbf{0.4095})*96485\mathbf{*2=}(0.3936)\mathbf{*2}=\mathbf{75.95}\ ^{kJ}/_{mol}$$

$$\mathbf{K}_{\mathbf{eq}Aerobic} = EXP(-\Delta \mathbf{G}_{\mathbf{eq}Aerobic}/R/T) = EXP(-75950/8.3144/298.15) = 10^{-13.3};$$

$$\mathbf{K}_{\mathbf{eq}Aerobic} = \frac{[NADH]\cdot[pyruvate^-]\cdot[H_3O^+]}{[NAD^+]\cdot[lactate^-]\cdot[H_2O]} = e^{-\frac{\Delta G_{eqAerobic}}{R \bullet T}} = \mathbf{e}^{-\frac{759500}{8.314 \bullet 298.15}} = \mathbf{10^{-13.3}};$$

$\Delta G_{Hess} = \Delta H_{Hess} - T*\Delta S_{Hess} = \mathbf{45.764} - 298.15* \mathbf{-0.5479605} = \mathbf{209.14}......\ ^{kJ}/_{mol}$ **endoergic**; formation 62nd , 75th pages

Pyruvate $H_3CC{=}OCOO^-$ decarboxylation $H_3CCHO+HCO_3^-$;$H_3CC{=}OCOO^-+H_2O\Delta G+Q\Rightarrow H_3CCHO+HCO_3$

Lactate  $+H_2O$=Ethanol  $+HCO_3^-+\Delta G+Q$; **exothermic, exoergic .**

$\Delta G_{Hess}=\Delta G^\circ_{H3CCH2OH}+\Delta G^\circ_{HCO3}-\Delta G^\circ_{H2O}-\Delta G^\circ_{H3CCH2OHCOO-}=\underline{75.2864-544.9688-(-151.549-303.4256)}=-14.71\ ^{kJ}/_{mol}$

$\Delta G_{Alberty}=\Delta G_{H3CCH2OH}+\Delta G_{HCO3}-\Delta G_{H2O}-\Delta G_{H3CCH2OHCOO-}=666.1+46.08-(0+668.8)=43.38\ ^{kJ}/_{mol}$

$\Delta G_{Alberty\_Biochem}=\Delta G_{H3CCH2OH}+\Delta G_{HCO3}\ G_{H2O\_Biochem}-\Delta G_{H3CCH2OHCOO-}=\underline{666.1+46.08-(85.64+668.8)}=-42.26\ ^{kJ}/_{mol}$

$\Delta H_{Hess}=\Delta H^\circ_{H3CCH2OH}+\Delta H^\circ_{HCO3}-\Delta H^\circ_{H2O}-\Delta H^\circ_{H3CCH2OHCOO-}=-290.77-692.4948-(-286.65-688.29)=-8.325\ ^{kJ}/_{mol}$

$\Delta S_{dispersed}=-\Delta H_{Hess}/T=8.325/298.15=27.9\ ^{J}/_{K/mol}$;

$\Delta S_{Hess}=\Delta S^\circ_{H3CCH2OH}+\Delta S^\circ_{HCO3}--\Delta S^\circ_{H2O}-\Delta S^\circ_{H3CCH2OHCOO-}=21.51\ ^{J}/_{mol/K}$;

$=-1227.764-494.768-(-453.188-1290.852)=21.51\ ^{J}/_{mol/K}$....

$\Delta S_{total}=\Delta S_{Hess}+\Delta S_{dispersed}=21.51+27.9=49.41\ ^{J}/_{mol/K}$;

$\Delta G_{Hess}=\Delta H_{Hess}-T*\Delta S_{Hess}=-8.325-298.15*0.02151=-14.738\ ^{kJ}/_{mol}$ **exoergic**......

$T\bullet\Delta S_{total}=0.04941*298.15\ K=14.73\ ^{kJ}/_{mol}$; bound $T\Delta S_n$ ;<u>dispersed-lost energy</u> **spontaneous**

**Lactic acid** Formation 71st page $3C+3H_{2gas}+1.5O_{2gas}\Rightarrow H_3CHC(OH)COOH$ ; $G_{H3CHC(OH)COOH}=-303.4\ ^{kJ}/_{mol}$ [8];

$\Delta G_{H3CHC(OH)COOH}=G_{H3CHC(OH)COOH}-(3G_{Cgraph}+3*G_{H2gas}+1.5*G_{O2gas})=-303.4\ ^{kJ}/_{mol}$;

$G_{H3CHC(OH)COOH}=-303.4+(3*91.26+3*85.6+1.5*303)=681.7\ ^{kJ}/_{mol}$;

Lactic acid $H_3CHC(OH)COOH+H_2O\Leftrightarrow H_3CHC(OH)COO^-+H_3O^+$; $pK_a=3.86$;

$K_{eq}=[H_3CHC(OH)COO^-]*[H_3O^+]/[H_3CHC(OH)COOH]/[H_2O]=K_a/[H_2O]=10^{\wedge(-3.86)}/55.3=2.5*10^{\wedge(-6)}=10^{\wedge(-5.603)}$;

$\Delta G_{eqH3CHC(OH)COOH}=-R\bullet T\bullet\ln(K_{aeq})=-8.3144*298.15*\ln(10^{\wedge(-5.603)})/1000=31.98\ ^{kJ}/_{mol}$ .

$\Delta G_{H3CHC(OH)COO}=G_{H3CHC(OH)COO}+2G_{H3O+}-(G_{LacticAc}+2G_{H2O})=G_{Succinat}+2*22.44-(681.7+2*0)=31.98\ ^{kJ}/_{mol}$;

$G_{H3CHC(OH)COO}=\Delta G_{H3CHC(OH)COO}-2G_{H3O+}+(G_{LacticAc}+2G_{H2O})=31.98-2*22.44+(681.7+2*0)=668.8\ ^{kJ}/_{mol}$;

**$CH_3CH_2OH$** ethanol formation from elements:

$2C+3H_{2gas}+1/2O_{2gas}\Rightarrow CH_3CH_2OH$ ; $\Delta G^\circ_{Alberty}=75.2864\ ^{kJ}/_{mol}$ ; $\Delta G^\circ_{HessCRC}=-181\ ^{kJ}/_{mol}$ ;

$\Delta G^\circ_{Alberty}=G_{CH3CH2OH}-(2G_{Cgraph}+3*G_{H2gas}+1/2*G_{O2gas})=75.2864\ ^{kJ}/_{mol}$ ;

$\Delta G^\circ_{CRC}=G_{CH3CH2OH}-(2G_{Cgraph}+3*G_{H2gas}+1/2*G_{O2gas})=-181\ ^{kJ}/_{mol}$ ;

$\Delta G^\circ_{Alberty}+(2G_{Cgraph}+3*G_{H2gas}+1/2*G_{O2gas})=75.2864+(2*91.26+3*85.6+1/2*303)=G_{CH3CH2OH}=666.106\ ^{kJ}/_{mol}$ ;

$\Delta G^\circ_{CRC}+(2G_{Cgraph}+3*G_{H2gas}+1/2*G_{O2gas})=-181+(2*91.26+3*85.6+1/2*303)=G_{CH3CH2OH}=409.82\ ^{kJ}/_{mol}$ ;

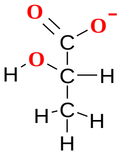
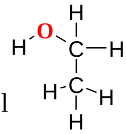
| *Substance* | $\Delta H^\circ_H\ ^{kJ}/_{mol}$ | $\Delta S^\circ_H\ ^{J}/_{mol/K}$ | $\Delta G^\circ_H\ ^{kJ}/_{mol}$ |
|---|---|---|---|
| **$H_3CCH(OH)COO^-$** | **-688.29** | **-1290.852** | **-303.4256** |
| **$H_3CCH(OH)COO^-$** | -686.2 | -557.71 | -313.70 |
| **$H_3CCH_2OH_{aq}$** | **-290.77** | **-1227.764** | **75.2864** |
| **$H_3CCH_2OH_l$** | -277.6 | 160.7 | 62.96 |
| **$H_2O$** | -285.85 | 69.9565 | -237.191 |
| **$H_2O$** | **-286.65** | **-453.188** | **-151.549** |
| **$HCO_3^-$** | -689.93 | 98.324 | -586.94 |
| **$HCO_3^-$** | **-692.4948** | **-494.768** | **-544.9688** |

**BioThermodynamics06;** $G_{H2O\_Biochem}=85.64\ ^{kJ}/_{mol}$;

$(G_{H3O+}+G_{HCO3-})=22.44+46.08\ ^{kJ}/_{mol}$ ;

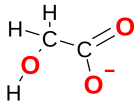
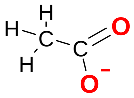
CRC 2010;

$\Delta S_{Hess}=\Sigma\Delta S^\circ_{products}-\Sigma\Delta S^\circ_{reactants}$;$\Delta G_{Hess}=\Delta H_{Hess}-T\bullet\Delta S_{Hess}$

Lactate  $+H_2O$=Ethanol  $+HCO_3^-+\Delta G+Q$

**exothermic**...........

Oks: $H_2COHCOO^-+\mathbf{H^-(H^++2e^-)+H_3O^+}=>\mathbf{H_3CCOO^-+2H_2O}$; $\mathbf{E^\circ_{Ox}}{}_{H2COHCOO}$=-0.033 V absolute; [23]

Oks: Glycolate  + NADH + $\mathbf{H_3O^+}$ => acetate  +2$\mathbf{H_2O}$ + $NAD^+$;

$\Delta G_{Hess}=\Delta G^\circ_{\mathbf{CH3COO}}+\Delta G^\circ_{\mathbf{NAD+}}+2\Delta G^\circ_{\mathbf{H2O}}-\Delta G^\circ_{H2COHCOO}-\Delta G^\circ_{\mathbf{NADH}}-\Delta G^\circ_{\mathbf{H3O}}=\mathbf{-161.8}$ $^{kJ}/_{mol}$;
=**-240.963**+**1112.534**-2*237.191-(**-403.2968**+**1175.5732**-213.2746)=**-161.8** $^{kJ}/_{mol}$ **exoergic**..........

Glycolate $H_2COHCOO^-+NADH+H_3O^+=>H_3CCOO^-+NAD^++2H_2O$;

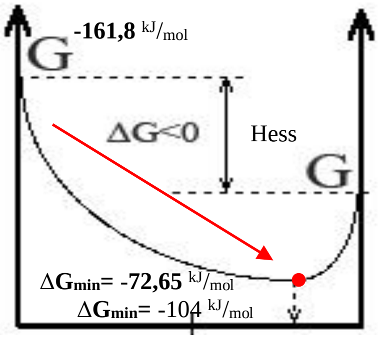
$\Delta \mathbf{G_{eq}}=(\mathbf{E^\circ}\ _{\mathbf{Red}}\mathbf{-E^\circ_{Ox}}{}_{H2COHCOO})\mathbf{*F*n}$=(-0.4095--0.033)*96485*2=(-0.38)*96485*2=**-72.65** $^{kJ}/_{mol}$;

| *Substance* Glyoxylate | $\Delta H^\circ_{Hess}$ $^{kJ}/_{mol}$ | $\Delta S^\circ_{Hess}$ $^{J}/_{mol/K}$ | $\Delta G^\circ_{Hess}$ $^{kJ}/_{mol}$ |
|---|---|---|---|
| OHCCOOH | - | - | - |
| $OHCCOO^-$ | - | - | **-426.588** |
| $H_2COHCOO^-$ | - | - | **-403.2968** |
| $H_2COHCOOH$ | - 651 | 318.6 | - |
| NADH$_{(aq)}$ | -1036.66 | -140.5 | - |
| NADH$_{(aq)}$ | **-1041.41** | **-4081.784** | **1175.5732** |
| $\mathbf{H_3O^+}_{(aq)}$ | -285.81 | -3.854 | -213.2746 |
| $NAD^+_{(aq)}$ | -1007.48 | -183 | - |
| $NAD^+_{(aq)}$ | **-1010.3** | **-3766.008** | **1112.534** |
| $\mathbf{H_3CCOOH}$ | -484.09 | 159.83 | -531.743 |
| $\mathbf{H_3CCOO^-}$ | -486.84 | 82.23 | -247.83 |
| $\mathbf{H_3CCOO^-}$ | **-486** | **85.3** | **-240.963** |
| $\mathbf{H_2O}$ | -285.85 | 69.9565 | -237.191 |
| $\mathbf{H_2O}$ | **.65** | **-453.188** | **-151.549** |

$H_2COHCOO^-+NADH+H_3O^+=>H_3CCOO^-+NAD^++H_2O$;

$G_{OHCCOOH}$=**-426.588**+(**2*91.26**+**85.6**+**1.5*303**)=**296.032** $^{kJ}/_{mol}$
$G_{OHCCOO}=\Delta \mathbf{G_{eq}}{}_{OHCCOOH}-G_{H3O+}+(G_{OHCCOOH}+G_{H2O})$=**305.6** $^{kJ}/_{mol}$
$G_{OHCCOO}=\Delta \mathbf{G_{eq}}{}_{OHCCOOH}-G_{H3O+}+(G_{OHCCOOH}+G_{H2O})$=**414.3** $^{kJ}/_{mol}$
$G_{H2COHCOOH}$=**-403.2968**+(**2*91.26**+2***85.6**+**1.5*303**)=**404.9232** $^{kJ}/_{mol}$

Exothermic, exoergic reduction
Hess free energy change **-161.8**
negative, but minimized
reaching $\Delta \mathbf{G_{min}=\Delta G_{eq}=-72.65}$
or
**-104** $^{kJ}/_{mol}$ equilibrium mixture.
Le Chatelier principle is
Prigogine attractor free energy
change minimum $\Delta G_{min}$
reaching.



A+B+C 50% D+2E+F

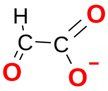
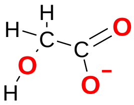
Glyoxylic acid Formation 61st page 2**C**+$\mathbf{H_{2gas}}$+1.5$\mathbf{O_2}{}_{gas}$=>OHCCOOH ; $\Delta G_{OHCCOOH}$=**-426.588** $^{kJ}/_{mol}$ [8];
$\Delta G_{OHCCOOH}=G_{OHCCOOH}$-(**2G**$_{Cgraph}$+$G_{\mathbf{H2}gas}$+**1.5***$G_{O2gas}$)= **-426.588** $^{kJ}/_{mol}$;
$G_{OHCCOOH}$=**-426.588**+(**2*91.26**+**85.6**+**1.5*303**)=**296.032** $^{kJ}/_{mol}$;

Glyoxylic acid $OHCCOOH+\mathbf{H_2O}<=>OHCCOO^-+H_3O^+$; p$K_{a1}$=3.32; Wikipedia
$K_{eq}=[OHCCOO^-]*[H_3O^+]/[OHCCOOH]/[\mathbf{H_2O}]=K_a/[\mathbf{H_2O}]$=10^(-3.32)/55.3=8.655*10^(-6)=10^(-5.063);
$\Delta \mathbf{G_{eq}}{}_{OHCCOOH}$=-R•T•ln($K_{\mathbf{aeq}}$)=-8.3144*298.15*ln(10^(-5.063))/1000=**31.98** $^{kJ}/_{mol}$ .
$\Delta \mathbf{G_{eq}}{}_{OHCCOOH}=G_{OHCCOO}+G_{H3O+}-(G_{OHCCOOH}+G_{H2O})=G_{OHCCOO}$+**22.44-(296.032+0)= 31.98** $^{kJ}/_{mol}$;
$G_{OHCCOO}=\Delta \mathbf{G_{eq}}{}_{OHCCOOH}-G_{H3O+}+(G_{OHCCOOH}+G_{H2O})$=**31.98-22.44**+(**296.032+0**)=**305.6** $^{kJ}/_{mol}$;

Glycolic acid Formation 61st page 2**C**+2*$\mathbf{H_{2gas}}$+1.5$\mathbf{O_2}{}_{gas}$=> $H_2COHCOOH$ ; $\Delta G_{H2COHCOOH}$=**-403.2968** $^{kJ}/_{mol}$ [8];
$\Delta G_{H2COHCOOH}=G_{H2COHCOOH}$-(**2G**$_{Cgraph}$+2$G_{\mathbf{H2}gas}$+**1.5***$G_{O2gas}$)= **-403.2968** $^{kJ}/_{mol}$;
$G_{H2COHCOOH}$=**-403.2968**+(**2*91.26**+2***85.6**+**1.5*303**)=**404.9232** $^{kJ}/_{mol}$;

Glycolic acid $H_2COHCOOH+\mathbf{H_2O}<=>H_2COHCOO^-+H_3O^+$; p$K_{a1}$=3.83; Wikipedia
$K_{eq}=[H_2COHCOO^-]*[H_3O^+]/[H_2COHCOOH]/[\mathbf{H_2O}]=K_a/[\mathbf{H_2O}]$=10^(-3.83)/55.3=2.675*10^(-6)=10^(-5.573);
$\Delta \mathbf{G_{eq}}{}_{OHCCOOH}$=-R•T•ln($K_{\mathbf{aeq}}$)=-8.3144*298.15*ln(10^(-5.573))/1000=**31.81** $^{kJ}/_{mol}$ .
$\Delta \mathbf{G_{eq}}{}_{OHCCOOH}=G_{OHCCOO}+G_{H3O+}-(G_{OHCCOOH}+G_{H2O})=G_{OHCCOO}$+**22.44-(404.9232+0)= 31.81** $^{kJ}/_{mol}$;
$G_{OHCCOO}=\Delta \mathbf{G_{eq}}{}_{OHCCOOH}-G_{H3O+}+(G_{OHCCOOH}+G_{H2O})$=**31.81-22.44**+(**404.9232+0**)=**414.3** $^{kJ}/_{mol}$;

Nernst's half reaction **glycolate** +$\mathbf{H_2O}$ = **Glyoxylate** +$\mathbf{H^-(H^++2e^-)+H_3O^+}$ ; D.C.Harris 25˚C [23]
Oks: $OHCCOO^-+\mathbf{H^-(H^++2e^-)+H_3O^+}=>H_2COHCOO^-+\mathbf{H_2O}$ ; $\mathbf{E^\circ}_{H2COHCOO}$=0.1305 V absolute;[23]

Oks: Glyoxylate  + NADH +$\mathbf{H_3O^+}$=> Glycolate  +$\mathbf{H_2O}$+$NAD^+$; D.C.Harris 25˚C [23]

Nernst's half reaction Red: **NADH = NAD**$^+$ **+** $\mathbf{H^-(H^++2e^-)}$; $\mathbf{E^\circ}\ _{\mathbf{Red}}$= -0.4095 V David Harris absolute [22]
Glyoxylate $OHCCOO^-+NADH+H_3O^+=H_2COHCOO^-+NAD^++H_2O$ Glycolate;

$\Delta G_{Hess}=\Delta G^\circ_{H2COHCOOH}+\Delta G^\circ_{\mathbf{NAD+}}+\Delta G^\circ_{\mathbf{H2O}}-\Delta G^\circ_{H2COHCOO}-\Delta G^\circ_{\mathbf{NADH}}-\Delta G^\circ_{\mathbf{H3O}}=\mathbf{-63.66}$ $^{kJ}/_{mol}$;
=**-403.2968**+**1112.534**-237.191-(**-426.588**+**1175.5732**-213.2746)=**-63.66** $^{kJ}/_{mol}$ **exoergic**..............;
$\Delta \mathbf{G_{min}}=\Delta \mathbf{G_{eq}}=(\mathbf{E^\circ_{eqNernst\_NADH}-E^\circ}{}_{H2COHCOO})\mathbf{*F*n}$=(-0.4095-0.1305)*96485*2=(-0.54)* 96485*2=**-104.2** $^{kJ}/_{mol}$;

**Nernst's potential $O_{2aqua}$/$H_2O$** red-ox system biochemical mechanism of acidosis and oxidative stress

(forced oxidizing agent power by potential E increase)

Note: Oxidative stress causes **non enzymatic** oxidation in multiple radical chain and reactions of parallel product formations to contaminate and destroy the organism! Destructive hazard for life!

Water medium (blood plasma) oxygen is strong oxidant absolute potential $E°_{O2}$=**1.0868** V oxidized form free electrons reduced form by half reaction: $O_{2aqua}+4H_3O^++4e^-$<=>$H_2O$;

Free energy content is gas and water solubility product $G_{O2aqua}=G_{O2gas}+G_{O2sp}=303.1+26.58=330$ kJ/mol ;

$G_{H3O+OH}=G_{H3O+}+G_{OH-}=22.44+77.36=99.8$ kJ/mol of $H_2O+H_2O$<=>$H_3O^++OH$

Biochemistry oxygen **$O_{2aqua}$** decreases free energy content $G_{O2aqua}=329.7$ kJ/mol to $G_{O2Biochemistry}=78.08$ kJ/mol. Concentration arterial $[O_{2aqua}]=6*10^{-5}$ M and pH=7.36 concentration $[H_3O^+]=10^{-7.36}$ M decrease potential:

$E_{O2}=E°+{}^{0.0591}/_4\bullet\log([O_{2aqua}]\bullet[H_3O^+]^4/_{[H2O]}{}^6)=\mathbf{1.0868}+{}^{0.0591}/_4*\log(6*10\wedge(^{-5})*10\wedge(^{-7.36*4})/_{55.346}{}^{\wedge6})=0.4349$ V with difference $\Delta E_{arterial}=E°-E_o=\mathbf{1.0868}-0.4349=-0.652$ V; $\Delta G_{arterial}=\Delta E_{H2O}*F*n=-0.652*96485*4/1000=-251.6$ kJ/mol. Solubility product value **$O_{2gas\ AIR}+H_2O$**$\underline{^{Aquaporins}}$=>**$O_{2Blood}$** increases about $G_{O2sp}=26.58$ kJ/mol:

$$\frac{[O_{2\ aqua}]}{[O_{2\ gas}]\cdot[H_2O]}=K_{sp}=2.205*10^{-5}.\ G_{O2sp}=\mathbf{-R\bullet T\bullet ln(K_{sp})}=-8.3144*298.15*\ln(2.205*10^{-5})=26.58\ ^{kJ}/_{mol}.$$

Free energy protolysis decreases $G_{O2Biochem\_arterial}=G_{O2aqua}+G_{O2sp}+\Delta G_{arterial}=303.1+26.58-251.6=78.08$ kJ/mol and oxygen becomes fire safe biochemical oxidant, forming arterial concentration [**$O_{2aqua}$**]$=6*10^{-5}$ M as safe Bioenergetic sustaining normal isooxia. [3];

Oxygen solubility Prigogine attractor free energy change Hess law solution **is** exothermic and endoergic **$O_{2air}$**$+H_2O$<=>**$O_{2aqua}$**+Q. Oxygen mol fraction [**$O_{2air}$**]=0.2095 in air, in water [**$O_{2aqua}$**]/[$H_2O$]:

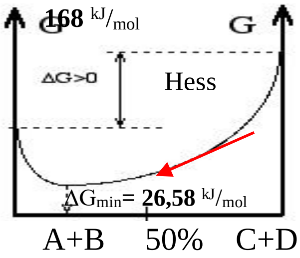
$\Delta G_{Hess}=\Delta G°_{O2aqua}-\Delta G°_{O2gas}-\Delta G°_{H2O}=\mathbf{16.4}-(0-\mathbf{151.549})=\mathbf{168}$ kJ/mol **endoergic**;

$\mathbf{\Delta G_{eq}=-R\bullet T\bullet ln(K_{eq})}=-8.3144*298.15*\ln(2.205*10^{-5})=-8.3144\bullet298.15\bullet6.414=\mathbf{26.58}$ kJ/mol

[**$O_2$**] solubility Hess free energy change is positive $\mathbf{\Delta G_{Hess}=\Delta G_{solubility}=168}$ kJ/mol , but minimized to $\mathbf{\Delta G_{min}=\Delta G_{eq}=26.58}$ kJ/mol reaching solubility product

$$\text{equilibrium mixture } \mathbf{K_{eq}}=\frac{[O_{2\ aqua}]}{[O_{2\ air}]\cdot[H_2O]}=2.205*10^{-5}=10^{-4.66}.$$

Equilibrium reaching is Prigogine attractor free energy change minimum $\mathbf{\Delta G_{min}}$ .



Reactant $O_2\uparrow_{gas}+H_2O$ products **$H_2O_{Blood}+O_{2aqua-Blood}$**.

Free energy change minimum $\Delta G_{min}$ reaching establishes equilibrium. 53rd page.

Zero osmolar $C_{osm}=0$ M and ionic force **I**=0 M in distilled water from air 20.95% solubility is:

solubility [**$O_{2water}$**]=**$K_{eq}$**$*$[**$O_{2air}$**]$*[H_2O]=2.205*10^{-5}*0.2095*55.3=2.5567*10^{-4}$ M.

ELSEVIER, Rotating Electrode Method and Oxygen reduction Electrocatalysts, 2014, p.1-31,

1. WeiXinga, MinYinb, QingLvb, YangHub, ChangpengLiub, JiujunZhangc. Pure 1atm mol fraction [**$O_{2gas}$**]=1. Osmolar $C_{osm}=0.305$ M, ionic force **I**=0.25 M, air oxygen 20.95% conditions dissolute **[$O_{2aqua}$]**=$9.768\cdot10^{-5}$ M. Therefore physiologic equilibrium constant is **$K_{O2blood}$**=[**$O_{2aqua}$**]/[**$O_{2air}$**]$=9.768\cdot10^{-5}/0.2095=4.663*10^{-4}=10^{-3.3314}$.

Arterial [**$O_{2aqua}$**]$=6\cdot10^{-5}$ M versus venous [**$O_{2aqua}$**]$=0.426\cdot10^{-5}$ M determines $pK_{O2Arterial}=3.3314$. Oxygen molecules cross membranes through aquaporins against gradient of osmolar concentration.

Ox: $O_{2aqua}+4H_3O^++4e^-\Leftrightarrow6H_2O$; $E°_{O2}$=**1.0868** Volts; Red: $\underline{\mathbf{4H(Pt)}}+4H_2O\Leftrightarrow4H_3O^++4e^-$ ; $E°_H=-0.2965$ V.

$O_{2aqua}+\underline{4H(Pt)}=2H_2O$; $\mathbf{\Delta G_{eq}}=(E°_H-E°_{O2})\bullet F\bullet1\bullet4=(-0.2965-\mathbf{1.0868})*96485*4=-1.383*96485*4/1000=-533.8$ kJ/mol;

Equilibrium value $\Delta G_{eq2H2O}=2G_{H2O}-4G_{H(Pt)}-G_{O2aqua}=2*0-(4*G_{H(Pt)}+\mathbf{330})=-533.8=2*266.9$ kJ/mol expresses metal free energy $G_{H(Pt)}=(2G_{H2O}-\mathbf{\Delta G_{eq2H2O}}-G_{O2aqua})/4=(2*0+533.9-\mathbf{330})/4=\mathbf{204.2}/4=\mathbf{51.05}$ kJ/mol .

$H_{2aq}+2H_2O\Leftrightarrow\mathbf{2H_3O^+}+2e^-+H_2O$; Nernst's half reaction

$\Delta \mathbf{G}_{Hess\_H3O+}=G_{\mathbf{H2}aq}+2G_{H2O}-(2G_{H3O+}+G_{H2O})=\mathbf{103.24}+2*0-(2*22.44-2*0)=58.36\ ^{kJ}/_{mol}$ ; and graphite electrode absolute potential $E^{\circ}_{H3O+}=58360/96485/2=0.302V$ oxidizes hydrogen and liberate (Pt) lattice.

**Red:** $2\underline{\mathbf{H}(Pt)}+2H_2O \Leftrightarrow 2H_3O^{+}+2e^{-}$; $E^{\circ}_{H+}=-0.2965$ V; **Ox+Red** summary $2\underline{\mathbf{H}(Pt)}\ \underline{+}H_2O \Leftrightarrow \mathbf{H}_{2aq}$;

$$\text{Ox: } 2\mathbf{H}_3O^{+}+H_2O+2e^{-} \Leftrightarrow \mathbf{H}_{2aq}+2H_2O;$$

$$\text{Red: } 2\underline{\mathbf{H}(Pt)}+2H_2O \Leftrightarrow 2H_3O^{+}+2e^{-};$$

$$2\underline{\mathbf{H}(Pt)}+H_2O \Leftrightarrow \mathbf{H}_{2aq};$$

$$\Delta E^{\circ}_{eqH3O+\mathbf{H}(Pt)}=-0.2965-0.302=-0.5985\text{ V}; \Delta\mathbf{G}_{eqH3O+\mathbf{H}(Pt)}=\Delta E^{\circ}_{eqH3O+\mathbf{H}(Pt)}\bullet F\bullet 2=-0.5985*96485*2=\mathbf{-115.5}\ ^{kJ}/_{mol};$$

$$\Delta\mathbf{G}_{eqH3O+\mathbf{H}(Pt)}=G_{\mathbf{H2}aq}+G_{\mathbf{H2O}}-2G_{\mathbf{H}(Pt)}=\mathbf{103.24}+0-2*\mathbf{51.05}=\mathbf{1.14}\ ^{kJ}/_{mol}\ .$$

$$\Delta\mathbf{G}_{eqH3O+\mathbf{H}(Pt)}=G_{\mathbf{H2}aq}+G_{\mathbf{H2O}\_Biochem}-2G_{\mathbf{H}(Pt)}=\mathbf{103.24}+\mathbf{85.6}-2*\mathbf{51.05}=\mathbf{86.74}\ ^{kJ}/_{mol}\ .$$

Platinum crystal lattice is indifferent referring to zero free energy for $G_{\mathbf{H2O}}=G_{\mathbf{CO2}gas}=G_{\underline{e-}}=0\ ^{kJ}/_{mol}$ ,

$$\text{Reduction of sulfur: } \mathbf{S}_{rhombic} + 2\ \mathbf{H_3O}^{+} + 2e^{-} = \mathbf{H_2S}_{aq} + 2\ H_2\mathbf{O};\ E^{\circ}_{S}=0.347\text{ V};$$

$$\mathbf{S}_{rhombic}+\underline{2\mathbf{H}(Pt)} \Leftrightarrow H_2\mathbf{S}_{aq};$$

$$\Delta\mathbf{G}_{\mathbf{eq}}=(E^{\circ}_{H}-E^{\circ}_{S})\bullet F\bullet 1\bullet 2=(0.10166-0.347)*96485*2=-0.245*96485*2/1000= -47.3\ ^{kJ}/_{mol};$$

$G_{\mathbf{H2S}aquq}=\Delta G_{\mathbf{HessH2S}}+(2G_{\mathbf{H}(Pt)}+G_{\mathbf{S}rhombic})=-47.3+(2*\mathbf{-219-85.64})=-571\ ^{kJ}/_{mol}$ . 3rd page.

## Abstract.

Alberty-based **Absolute** free energy content $G_{\mathbf{H2}gas}=\mathbf{85.6}\ ^{kJ}/_{mol}$ for gas, $G_{\mathbf{H2}aqua}=\mathbf{103}\ ^{kJ}/_{mol}$ for water and $G_{H(Pt)}=\mathbf{51}\ ^{kJ}/_{mol}$ for metallic hydrogen at zero reference $G_{\mathbf{H2O}}=G_{\mathbf{CO2}gas}=0\ ^{kJ}/_{mol}$ background energy for water and carbon dioxide for $\mathbf{CO}_{\mathbf{2}gas}$ gas. [8,15] Metal hydrogen zero classic standard potential reference is used in its hydroxonium cations $\{H_3O^{+}\}=1.01$ M solution of sulfuric acid concentration $[H_2SO_4]=1$ M with 1.061 $^{g}/_{mL}$ density. Since Nernst Nobel Prize in Chemistry 1920th all electrochemistry series reductant oxidation half reactions standard potentials are determined relative to hydrogen metal half reaction classic standard potential $E^{\circ}_{H}$ zero. [1] Quantitative studies of the functional activity of oxygen, carbon dioxide and water protolysis reveal generated diverse Life-Organization Attractors: water concentration $[H_2O]=55.3\ ^{mol}/_{Liter}$, pH=7.36, reactivity of the enzyme carbonic anhydrase (CA), air oxygen level 20.95 % , osmolar concentration 0.305 M, ionic strength 0.25 M, temperature 310.15 K degrees, etc. . [1,15]

High rate protolysis in water make oxygen fire safe , CA functionally activates carbon dioxide by reacting with two water molecules to produce $\mathbf{H_3O^{+}+HCO_3^{-}}$ concentration gradients on either side of the membrane for osmosis against concentration gradients but for the transport of protons and bicarbonate ions down through protons and bicarbonate ions channels.

Former publications reveal indispensible accounting the water and hydroxonium in Thermodynamic expressions of equilibrium reactions including protolysis and electrochemistry Nernst's half reactions. [8,14,15] Studies reach a reference value of 0.10166 Volts for the thermodynamic standard potential of metallic hydrogen. Behalf of Alberty given data about free energy of Hydrogen $G_{\mathbf{H2}gas}=\mathbf{85.6}\ ^{kJ}/_{mol}$ , $G_{\mathbf{H2}aqua}=\mathbf{103}\ ^{kJ}/_{mol}$ have detected the **Absolute** standard **Potential** $E^{\circ}_{H}=-0.2965$ Volts as Thermodynamic reference value of electrode with **Absolute** Free Energy change value $\Delta\mathbf{G}_{\mathbf{eq}}=\mathbf{-28.6}\ ^{kJ}/_{mol}$.

***Key Words:*** *Physical Chemistry; Electrochemistry; Thermodynamics; Attractors; Biochemistry.*

# Nernst's potential $O_{2aqua}$ / $H_2O$ | $\underline{H(Pt)}$ / $H_3O^+$ un $H_2O_2$ / $H_2O$ | $H_2O_2$ / $O_2$ studies

Ox oxidizing reactant half reaction: $O_{2aqua} + 4H_3O^+ + 4e^- <=> 6\ H_2O$ ; $G_{O2aqua}=\mathbf{330}\ ^{kJ}/_{mol}$ ; $E°_{O2}=\mathbf{0.9851}V$:

Red reducing reactant half reaction: $4\underline{\mathbf{H}(Pt)} + 4H_2O ⇔ 4\ H_3O^+ + 4e^-$ ; metal hydrogen $\mathbf{G}_{H(Pt)}=\mathbf{51.05}\ ^{kJ}/_{mol}$ :

$O_{2aqua}+\underline{4\mathbf{H}(Pt)}⇔2H_2O$ ; $Δ\mathbf{G}_{\mathbf{eq}}=2G_{\mathbf{H2O}}-4G_{\mathbf{H}(Pt)}-G_{\mathbf{O2}aqua}=(2*0-4G_{\mathbf{H}(Pt)}-\mathbf{330})=-533.886\ ^{kJ}/_{mol}$

$E_{\mathbf{O2}}=E°_{\mathbf{O2}}+0.0591/4•lg([O_{2aqua}]*[H_3O^+]^4/[H_2O]^6)=\mathbf{0.9851}+0.0591/4*log([O_{2aqua}]*[H_3O^+]^4/[H_2O]^6)$ ;

$E_H= E°_H+0.0591•lg([H_3O^+]/[H_2O])= \mathbf{-0.2965}\ V +0.0591•lg([H_3O^+]/[H_2O])$ ; $E°_H=\mathbf{-0.2965}\ V$ .

Gas $O_{2gas}+\underline{2H_{2gas}}⇔2H_2O$; $ΔG_{\mathbf{Hess2H2O}}=2ΔG°_{\mathbf{H2O}}-(2ΔG°_{\mathbf{H2}gas}+ΔG°_{\mathbf{O2}gas})=2*-237.19-(2*0+0)=2*-237.19=-546.4\ ^{kJ}/_{mol}$

$O_{2aqua}+\underline{2H_{2aqua}}⇔2H_2O$; $ΔG_{Alberty\mathbf{2}H2O}=2G_{\mathbf{H2O}}-2G_{H2aqua}-G_{O2aqua}=2*0-(2*\mathbf{103.24}+\mathbf{330})=\mathbf{-536.48}=2*\mathbf{268.24}\ ^{kJ}/_{mol}$;

Hydrogen Alberty R.A. Biochemical Thermodynamic's 1-463. (2006) free energy $G_{\mathbf{H2}aqua}=\mathbf{103}\ ^{kJ}/_{mol}$ .

| *Substance* | $ΔH°_H,^{kJ}/_{mol}$ | $ΔS°_H,^{J}/_{mol/K}$ | $ΔG°_H,^{kJ}/_{mol}$ |
|---|---|---|---|
| $\mathbf{H_2O}$ | -285.85 | 69.9565 | -237.191 |
| $\mathbf{H_2O}$ | **-286.65** | **-453.188** | **-151.549** |
| $\mathbf{H_3O^+}$ | -285.81 | -3.854 | -213.2746 |
| $\mathbf{H_{2(aq)}}$ | 23.4 | -130 | 99.13 |
| $\mathbf{O_2}aqua$ | **-11.70** | **-94.2** | **16.4** |
| $\mathbf{O_2}aqua$ | -11.715 | 110.876 | 16.4 |

$ΔG_{Hess}=2ΔG°_{\mathbf{H2O}}-4ΔG_{\mathbf{H}(Pt)}-ΔG°_{O2aqua}=-694.98=2*\mathbf{347.5}\ ^{kJ}/_{mol}$;

$=2*-237.191-(4*\mathbf{51.05}+\mathbf{16.4})=-694.98=2*\mathbf{347.5}\ ^{kJ}/_{mol}$. CRC 2010

$ΔG_{eq}=-533.886\ ^{kJ}/_{mol}$ ; $ΔG_{Hess}= -689\ ^{kJ}/_{mol}$

in reaction $4\underline{\mathbf{H}(Pt)} + O_{2aqua} ⇔ 2\ H_2O$ ; absolute values

$|ΔG_{eq}=\mathbf{-494.62}\ ^{kJ}/_{mol}| < |ΔG_{Hess}= -689\ ^{kJ}/_{mol}|$;

$[H_2O]^6$ logarithm of $E°_{\mathbf{O2}classic}=1.229$ V thermodynamic potential

$E°=1.383+0.10166=1.485$ V absolute $E°=1.485-0.3982=\mathbf{1.0868}$ V

$Δ\mathbf{G}_{\mathbf{eqOxRed}}=(E°_H-E°_{\mathbf{O2}})•F•1•4=(\mathbf{-0.2965-1.0868})*96485*4=-1.383*96485*4/1000=-533.9=2*\mathbf{-266.9}\ ^{kJ}/_{mol}$ ;

$\mathbf{K}_{\mathbf{eq2}H2O}\mathbf{=exp(-ΔG}_{OxRed}\mathbf{/R/T})=exp(\mathbf{533870.8}/8.3144/298.15)=exp(215.363)=10^{93.53}$

$G_{\mathbf{H}(Pt)}=(2G_{\mathbf{H2O}}-Δ\mathbf{G}_{\mathbf{eq}2H2O}-G_{\mathbf{O2}aqua})/4=(2*0+\mathbf{533.871-330})/4=\mathbf{204.2/4=51.05}\ ^{kJ}/_{mol}$

Exothermic and exoergic $O_{2aqua}$ reduction with metallic hydrogen $4\underline{\mathbf{H}(Pt)}$ and $H_2O_2$ dismutation Hess free energy change negative $ΔG_{\mathbf{Hess2H2O}}\mathbf{=-344.5}$....... $^{kJ}/_{mol}$ , $ΔG_{Homeostasis\_H2\mathbf{O2}}\mathbf{=-242.9}$........ $^{kJ}/_{mol}$, but minimized reaching equilibrium $Δ\mathbf{G}_{\mathbf{eq}2H2O}\mathbf{=-247}\ ^{kJ}/_{mol}$ and $Δ\mathbf{G}_{eqStandart}\mathbf{=-238.5}$........$^{kJ}/_{mol}$ mixture constants $\mathbf{K}_{\mathbf{eq}2H2O}=10^{86.65}$......... and $\mathbf{K}_{eqStandard}=10^{38.35}$.........

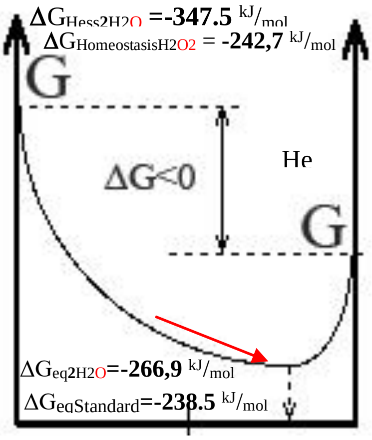
The minimum $ΔG_{min}$ is Prigogine attractor. Free energy change minimum reaching establish equilibrium state.

On absolute potential scale Nernst's half reactions standard potentials are:

Red $H_2O_2+2\ H_2O=O_{2aqua}+2\ H_3O^++2\ e^-$; $\mathbf{E°}_{H2\mathbf{O2}}=0.4495$ V Alberta University ;

Oks $H_2O_2 + 2\ H_3O^+ + 2\ e = 4\ H_2O$ ; $\mathbf{E\ °_{Ox}}=1.6855$ V Suhotina ;

$\mathbf{2H_2O_{2\mathit{aq}}=>O_{2aqua}+2H_2O+Q}+\mathbf{ΔG}$;



Reactants $4\underline{\mathbf{H}(Pt)}+ O_{2aqua}$ and products $2H_2O$

Reactants $\mathbf{2H_2O_{2\mathit{aq}}}$ and products $O_{2aqua}+2H_2O$

4A+B 50% 2D

2A 50% B+2C

$ΔG_{Hess}=\underline{G_{\mathbf{O2}aqua}+2*G_{\mathbf{H2O}}-2*G_{\mathbf{H2O2}}=\mathbf{16.4}+2*\mathbf{-151.549}-2*-134=-18.7}\ ^{kJ}/_{mol}$;

$ΔG_{HessCRC}=\underline{G_{\mathbf{O2}aqua}+2*G_{\mathbf{H2O}}-2*G_{\mathbf{H2O2}}=16.4+2*-237.19-2*-134=-189.98}\ ^{kJ}/_{mol}$;

$ΔG_{eqStandard}=(E_{Red}-E_{oOx})*\mathbf{F*n}=(0.4495-1.6855)*96485*2=(-1.24)*96485*2=\mathbf{-238.51}\ ^{kJ}/_{mol}$ ;

$ΔG_{AlbertyStandard}=\underline{G_{\mathbf{O2}Biochem\_arteriaj}+2*G_{\mathbf{H2O}BioChemistry}-2*G_{\mathbf{H2O2}}=\mathbf{78.08+2*85.64-2*284.25=-238.51}}\ ^{kJ}/_{mol}$; **Alberty**

$\underline{2G_{\mathbf{H2O2}}=G_{\mathbf{O2}aqua}+2*G_{\mathbf{H2O}}+ΔG_{AlbertyStandard}=\mathbf{330+2*0+238.51}=2*\mathbf{284.5=568.5}}\ ^{kJ}/_{mol}$;

$$\mathbf{K_{eq}}_{Standard}=\frac{[O_2]_{aqua}\cdot[H_2O]^2}{[H_2O_2]^2_{aqua}}=\mathbf{K}_{\mathbf{H2O2}}\mathbf{=exp(-ΔG}_{eq}\mathbf{/R/T)}=exp(238510/8.3144/298.15)=10^{41.75}........$$

Red: $E_{oH2\mathbf{O2}}=E°_{H2\mathbf{O2}}+0.0591/2•lg(O_{2aqua}]*[H_3O^+]^2/[H_2O_2]/[H_2O]^2)_{=0.4495+0.0591/2*lg(6*10^{\wedge(-5)}*10^{\wedge(-7.36*2)}/1/55.3^{\wedge 2})=}-0.213$ V

Ox: $E_{oOx}=E°_{H2\mathbf{O2}Ox}+0.0591/2•log([H_2O_2]*[H_3O^+]^2/[H_2O]^4)=1.6855+0.0591/2*lg(1*10^{\wedge(-7.36*2)}/55.3^{\wedge 4})=1.0445$ V

Homeostasis: $Δ\mathbf{G}_{\mathbf{eq}BioChem}=(E_{Red}-E_{oOx})*\mathbf{F*n}=(-0.2132-1.0445)*96485*2=(-1.258)*96485*2=\mathbf{-242.7}\ ^{kJ}/_{mol}$;

1.$\mathbf{ΔH}_{Hess}\mathbf{=ΔH°}_{\mathbf{O2}}\mathbf{+2ΔH°}_{\mathbf{H2O}}-2ΔH°_{\mathbf{H2O2}}=\mathbf{-11.7}-2*\mathbf{286.65}-(2*\mathbf{-191.99})=\mathbf{-201.02}\ ^{kJ}/_{mol}=-11.7-2*285.85-(2*-191.17)=-201.06\ ^{kJ}/_{mol}$

2.$ΔS_{dispersed}=-ΔH_H/T=-(\mathbf{-201.02})/298.15=\mathbf{674.2}\ ^{J}/_{mol/K}$ ; $ΔS_{dispersed}=-ΔH_H/T=-(-201.06)/298.15=674.36\ ^{J}/_{mol/K}$ ;

$\mathbf{ΔS}_{Hess}\mathbf{=ΔS°}_{\mathbf{O2}}\mathbf{+2ΔS°}_{\mathbf{H2O}}-2\mathbf{ΔS°}_{\mathbf{H2O2}}=\mathbf{-94.2}+2*\mathbf{-453.188}-(2*\mathbf{-481.688})=\mathbf{-37.2}\ ^{J}/_{mol/K}$**;**

$\mathbf{ΔS}_{Hess}\mathbf{=ΔS°}_{\mathbf{O2}}\mathbf{+2ΔS°}_{\mathbf{H2O}}-2\mathbf{ΔS°}_{\mathbf{H2O2}}=110.876+2*69.9565-(2*143.9)=-37\ ^{J}/_{mol/K}$**;**

2. $ΔS_{total}=ΔS_H+ΔS_{dispersed}\mathbf{=-37.2+674.2=637}$.....$^{J}/_{mol/K}$ $ΔS_{total}=-37.011+674.36=637.35$......$^{J}/_{mol/K}$**;**

4. $\mathbf{ΔG}_{Hess}\mathbf{=ΔH}_H\mathbf{-T*ΔS}_H\mathbf{=-201.02}-298.15*\mathbf{-0.0372=-189.9}\ ^{kJ}/_{mol}$ **exoergic spontaneous**.

$ΔG_{Hess}=\mathbf{ΔH}_H-T*\mathbf{ΔS}_H=-201.06-298.15*-0.037=-190\ ^{kJ}/_{mol}$ ;

$T•ΔS_{total}=\mathbf{0.637}*298.15=\mathbf{189.9}\ ^{kJ}/_{mol}$ ; $T•ΔS_{total}=0.63735*298.15=190\ ^{kJ}/_{mol}$;

**Nernst's potential** studies reducing with vitamin B$_3$ ethanal $H_3CCH{=}O$ and oxidising $H_3CCH_2OH$ ethanol

Aerobic [**NAD**$^+$]/[**NADH**]=10$^6$; $\mathbf{H_3C\text{-}CH_2\text{-}OH}+NAD^+\mathbf{+H_2O}+\Delta G\mathbf{+Q}\Rightarrow \mathbf{H_3C\text{-}CH{=}O}+NAD\mathbf{H+H_3O^+}$

$\Delta G_{Hess}=\Delta G°_{H3O}+\Delta G°_{CH3CHO}+\Delta G°_{NADH}-\Delta G°_{CH3CH2OH}-\Delta G°_{H2O}-\Delta G°_{NAD+}=159.1$ kJ/mol;

$\Delta G_{Hess}=\mathbf{32.2824+1175.5732-151.549}-(\mathbf{75.2864}+1059.11-237.191)=159.1$ kJ/mol endoergic;

$\Delta G_{HessAlbertyCH3CH2OH}=G_{NADH}+G_{H3O+}+\mathbf{G_{CH3CHO}}-(G_{NAD+}+\mathbf{G_{CH3CH2OH}}+G_{H2O})=\underline{\mathbf{68.02}}$ kJ/mol;

$\underline{=\mathbf{1112.534+22.44+32.282-(1175.5+75.2864-151.549)=68.02}}$ kJ/mol.

**Ox NAD$^+$+H$^-$(2e$^-$)<=>NADH** ; absolute potential **E°$_{NADH}$**=-0.4095 V; David Harris; [22]

**Red CH$_3$CH$_2$OH+2H$_2$O⇔CH$_3$CHO+2H$_3$O$^+$**+H$^-$(2e$^-$); absolute potential **E°$_{CH3CH2OH}$**=-0.055 V; [19]

By convention balanced **n = 2 = m** number of electrons **2e$^-$ΔE°** is expressed as **E°$^2_{H2O}$** of the electron **donor** minus **E°$^1$** of the electron **acceptor**. Because **NAD$^+$** is **accepting** electrons from **ethanol** :

$\mathbf{\Delta G_{min}=\Delta G_{eq}}=(\mathbf{E°_{eqNernsCH3CH2OH}-E°_{NAD+}})\mathbf{*F*n}=(-0.055+0.4095)*96485*2=(\mathbf{0.3545})*96485*2=\mathbf{68.408}$ kJ/mol;

$$\mathbf{\Delta G_{eq}=-R\bullet T\bullet \ln(K_{eq})};\ \mathbf{K_{eq}}=\frac{[NADH]\cdot[CH_3CHO]\cdot[H_3O^+]}{[NAD^+]\cdot[CH_3CH_2OH]\cdot[H_2O]}=e^{-\frac{\Delta Geq}{R\bullet T}}=e^{-\frac{68408}{8.314\bullet 298.15}}=\mathbf{1.036\bullet10^{-12}=10^{-11.985}}$$

Anaerobic [**NADH**]/[**NAD$^+$**]=10; $\mathbf{H_3C\text{-}CH_2\text{-}OH}+NAD^+\mathbf{+H_2O}+\Delta G\mathbf{+Q}\Rightarrow \mathbf{H_3C\text{-}CH{=}O}+NAD\mathbf{H+H_3O^+}$;

$\Delta G_{Hess}=\Delta G°_{CH3CH2OH}+\Delta G°_{H2O}+\Delta G°_{NAD+}-\Delta G°_{H3O}-\Delta G°_{CH3CHO}-\Delta G°_{NADH}=-159.1$ kJ/mol;

$\Delta G_{Hess}=\mathbf{75.2864}+1059.11-237.191-(\mathbf{32.2824+1175.5732-151.549})=-159.1$ kJ/mol endoerģiska;

$\Delta G_{HessAlbertyCH3CH2OH}=G_{NAD+}+\mathbf{G_{CH3CH2OH}}+G_{H2O}-(G_{NADH}+G_{H3O+}+\mathbf{G_{CH3CHO}})=\underline{\mathbf{-68.02}}$ kJ/mol;

$\underline{=\mathbf{1175.5+75.2864-151.549-(1112.534+22.44+32.282)=-68.02}}$ kJ/mol.

**Red NADH <=> NAD$^+$ + H$^-$(2e$^-$);** absolute potential **E°$_{NADH}$**=-0.4095 V; David Harris; [22];

**Ox CH$_3$CHO+2H$_3$O$^+$+H$^-$(2e$^-$)<=>CH$_3$CH$_2$OH+2H$_2$O**; absolute potential **E°$_{CH3CH2OH}$**=-0.055 V; [19].

By convention balanced **n=2=m** number of electrons **2e$^-$ΔE°** is expressed as **E°$^1$** of the electron **donor** minus **E°$^2_{H2O}$** of the electron **acceptor**. Because **CH$_3$CHO** is **accepting** electrons from **NADH** in our example

$\mathbf{\Delta G_{min}=\Delta G_{eq}}=(\mathbf{E°_{NAD+}-E°_{eqNernsCH3CH2OH}})\mathbf{*F*n}=(-0.4095+0.055)*96485*2=(\mathbf{-0.3545})*96485*2=\mathbf{-68.408}$ kJ/mol;

$$\mathbf{\Delta G_{eq}=-R\bullet T\bullet \ln(K_{eq})};\ \mathbf{K_{eq}}=\frac{[NAD^+]\cdot[CH_3CH_2OH]\cdot[H_2O]}{[NADH]\cdot[CH_3CHO]\cdot[H_3O^+]}=e^{-\frac{\Delta Geq}{R\bullet T}}=e^{-\frac{-68408}{8.314\bullet 298.15}}=\mathbf{9.65\bullet10^{11}=10^{11.985}}$$

In aerobic organisms NADH oxidase with **O$_{2aqua}$** perform ratio [**NAD$^+$**]/[**NADH**]=10$^6$;
**ΔG$_{Homeostasis}$=68.408+ R•T•ln**($10^6*1/1*10^{-7.36}/55.3$)=**68.408**-86.2= -17.8..........kJ/mol.
[**NAD$^+$**]/[**NADH**]=10$^3$; ΔG$_{Homeostasis}$=**68.408**-69.08= -0.676..........kJ/mol.

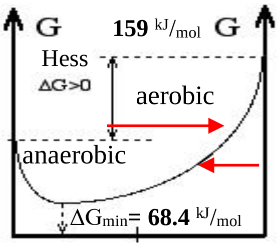
Equilibrium is shifted far to **reactants** as aerobic constant **K$_{eq}$** =10$^{-11.985}$ and asymmetric anaerobic constant **K$_{eq}$** =10$^{11.985}$. Aerobic endothermic and endoergic vitamin B$_3$ ethanol oxidation Hess law free energy change pozitive **ΔG$_{Hess}$**= 159........kJ/mol and asymmetric ethanal anaerobic reduction negative **ΔG$_{Hess}$**= -159........kJ/mol , but minimises reaching equilibrium aerobic **ΔG$_{min}$=ΔG$_{eq}$**= 68.4....... kJ/mol and anaerobic **ΔG$_{min}$**=**ΔG$_{eq}$**= -68.4....... kJ/mol reaching equilibrium mixture constants **10$^{-11.985}$**=**K$_{eq}$** aerobic and anaerobic **10$^{11.985}$**=**K$_{eq}$**.

Prigogine attractor is free energy change absolute minimum **ΔG$_{min}$** reaching equilibrium **ΔG$_{min}$**=68.4....... kJ/mol= |**ΔG$_{eq}$**| < |**ΔG$_{Hess}$**| = **159**........kJ/mol.

Anaerobic $\mathbf{H_3C\text{-}CH{=}O}+NAD\mathbf{H+H_3O^+}\Rightarrow\mathbf{H_3C\text{-}CH_2\text{-}OH}+NAD^+\mathbf{+H_2O}+\Delta G\mathbf{+Q}$;

Anaerobic ΔG$_{eq}$=ΔE°•F•n=-0.3545 V•2 mol•96485 C/mol= -68.408......... kJ/mol favored.

Insufficient low **O$_{2aqua}$** concentration hypoxia to anaerobic alcohol oxidation unflavored but ethanal reduction to ethanol favored [**H$_3$CCH$_2$OH**]/[ **H$_3$CCH=O**]=1/10 **homeostasis** reduction with NADH reductase enzyme as negative free energy change **ΔG$_{Homeostasis}$**= -27.86........kJ/mol

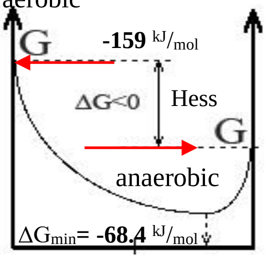


A+B+C50%D+E+F

reactants – NAD$^+$+H$_3$CCH$_2$OH+H$_2$O

products – NADH+H$_3$CCHO+H$_3$O$^+$

aerobic



D+E+F 50% A+B+C

NADH+H$_3$CCHO+H$_3$O$^+$

NAD$^+$+H$_3$CCH$_2$OH+H$_2$O

Anaerobic homeostasis ratio [**NADH**]/[**NAD$^+$**]=10 over [**NAD$^+$**] favors reduction:

**ΔG$_{Homeostasis}$=-68.41+**8.3144*298.15***ln(K$_{Homeostasis}$)=-68.41+40.54 = -27.86**........ **kJ/mol**

$$\mathbf{\Delta G_{Homeostasis}=-68.41}+8.3144*298.15*\mathbf{\ln}\left(\frac{1}{10}\ \frac{1}{10}\ \frac{55.333}{10^{-7.36}}\right)=\mathbf{-27.86}\ \mathbf{kJ/mol}\ ;\ \mathbf{K_{Homeostasi}}=\frac{[NAD^+]\cdot[CH_3CH_2OH]\cdot[H_2O]}{[NADH]\cdot[CH_3CHO]\cdot[H_3O^+]}$$

[**NADH**]/[**NAD$^+$**]=1/770; **ΔG$_{Homeostasis}$=68.408+8.3144*298.15*ln**($700/1*1/1*55.3457/10^{-7.36}$)=0.028 kJ/mol.

High rate protolysis peroxide anions $\mathbf{H^{+}+HOO^{-}><{}^{-}OOH+H^{+}}$ collision activation energy is high **Ea**=79000 $^{J}/_{mol}$ opposite $\mathbf{HOO^{-}=>Fe^{3+}}$ collision activation energy **Ea**=29 $^{J}/_{mol}$ catalysts is small. Producing ω=6, ω=3 fatty acids:

$\mathbf{2H_2O_{2(aq)}}<=>\mathbf{O_{2aqua}+2H_2O+Q+\Delta G_H}$ ;

$\Delta G_{Hess}=\Delta G^\circ_{O2}+2\Delta G^\circ_{H2O}-2\Delta G^\circ_{H2O2}=16.40+2*(-237.191)-(2*-134.03)=\mathbf{-189.9}.........\ ^{kJ}/_{moll}$ **exoergic**

$\Delta G_{HessAlberty}=G^\circ_{O2}+2G^\circ_{H2O}-2G^\circ_{H2O2}=303.1+2*(0)-(2*\mathbf{364.79})=\mathbf{-426.5}.......^{kJ}/_{moll}=\mathbf{-213.25}*2......^{kJ}/_{moll}$ **exoergic**

| *Substance* | $\Delta H^\circ_H,^{kJ}/_{mol}$ | $\Delta S^\circ_H,^{J}/_{mol/K}$ | $\Delta G^\circ_H,^{kJ}/_{mol}$ |
|---|---|---|---|
| $\mathbf{H_3O^+}$ | -285.81 | -3.854 | -213.275 |
| $\mathbf{O_{2aqua}}$ | -11.715 | 110.876 | 16.4 |
| $\mathbf{O_{2aqua}}$ | **-11.70** | **-94.2** | **16.40** |
| $\mathbf{H_2O}$ | -285.85 | 69.9565 | -237.191 |
| $\mathbf{H_2O}$ | **-286.65** | **-453.188** | **-151.549** |
| $\mathbf{H_2O_{2\,(aq)}}$ | **-191.99** | **-481.688** | **-48.39** |
| $\mathbf{H_2O_{2(aq)}}$ | -191.17 | 143.9 | -134.03 |
| $\mathbf{H_2O_{2\,l}}$ | -237.129 | 69.91 | -237.129 |

1. $\Delta H^\circ_{Hess}=\Sigma\Delta H^\circ_{products}-\Sigma\Delta H^\circ_{reactants}$; 3. $\Delta G^\circ_{Hess}=\Delta H^\circ_H-T\bullet\Delta S^\circ_H$;

Miščenko 1968. Himia, Leningrad 2.$\Delta S^\circ_{Hess}=\Sigma\Delta S^{\circ\circ}_{products}-\Sigma\Delta S^\circ_{reactants}$

CRC 2010; 2.$\Delta S^\circ_{Hess}=\Sigma\Delta S^{\circ\circ}_{products}-\Sigma\Delta S^\circ_{reactants}$

$\Delta H_{Hess}=\Delta H^\circ_{O2}+2\Delta H^\circ_{H2O}-2\Delta H^\circ_{H2O2}=\mathbf{-201.02}.....=-201.06......^{kJ}/_{mol}$

$=\mathbf{-11.7}-2*\mathbf{286.65}-(2*\mathbf{-191.99})=\mathbf{-201.02}......^{kJ}/_{mol}$ **eksotermiska**..

$=-11.7-2*285.85-(2*-191.17)=-201.06......^{kJ}/_{mol}$

**BiochemThermodynamic 2006** Masachusets Technology institute University Alberta 1997.

2.$\Delta S_{dispersed}=-\Delta H_H/T=-(\mathbf{-201.02})/298.15=\mathbf{674.2}\ .....^{J}/_{mol/K}$ ; $\Delta S_{dispersed}=-\Delta H_H/T=-(-201.06)/298.15=674.36....^{J}/_{mol/K}$ ;

$\Delta S_{Hess}=\Delta S^\circ_{O2}+2\Delta S^\circ_{H2O}-2\Delta S^\circ_{H2O2}=\mathbf{-94.2}+2*\mathbf{-453.188}-(2*\mathbf{-481.688})=\mathbf{-37.2}....^{J}/_{mol/K}$;

$\Delta S_{Hess}=\Delta S^\circ_{O2}+2\Delta S^\circ_{H2O}-2\Delta S^\circ_{H2O2}=110.876+2*69.9565-(2*143.9)=-37....^{J}/_{mol/K}$;

2. $\Delta S_{total}=\Delta S_H+\Delta S_{dispersed}=\mathbf{-37.2+674.2=637}.....^{J}/_{mol/K}$ $\Delta S_{total}=-37.011+674.36=637.35......^{J}/_{mol/K}$;

4. $\Delta G_{Hess}=\Delta H_H-T*\Delta S_H=\mathbf{-201.02}-298.15*\mathbf{-0.0372}=\mathbf{-189.9}........\ ^{kJ}/_{mol}$ **exoergic**............ **spontaneous**...........

$\Delta G_{Hess}=\Delta H_H-T*\Delta S_H=-201.06-298.15*-0.037=-190........\ ^{kJ}/_{mol}$ ;

$T\bullet\Delta S_{total}=\mathbf{0.637}*298.15=\mathbf{189.9}.........^{kJ}/_{mol}$ ; $T\bullet\Delta S_{total}=0.63735*298.15=190.........^{kJ}/_{mol}$;

$[H_2O_2]$= 1; $10^{\wedge(-10)}$ M homeostasis concentration $[O_{2aqua}]=6*10^{-5}$ M, $[H_3O^+]=10^{-7,36}$ M, $[H_2O]$=55,3 M.

**Red** $H_2O_2+2H_2O=O_2+2H_3O^++2e^-$; $\mathbf{E}^\circ_{H2O2}$=0,4495 V **Absolute** standard potenciāls; $E_{Red}=E^\circ_{H2O2}+0{,}0591/2\bullet$
$\bullet lg([O_{2aqua}]*[H_3O^+]^2/[H_2O_2]/[H_2O]^2)$==0,4495+0,0591/2*log(6*10^(-5)*10^(-7,36*2)/10^(-10)/55,3^2)=0,08227 V

$E_{Red}=E^\circ_{H2O2}+0.0591/2\bullet lg([O_{2aqua}]*[H_3O^+]^2/[H_2O_2]/[H_2O]^2)$=0,4495+0.0591/2*lg(6*10^(-5)*10^(-7.36*2)/1/55.3^2)=-0.2132 V

**Ox** $H_2O_2+2\ H_3O^++2e^-=4H_2O$; $\mathbf{-E^\circ_{Ox}}_{H2O2}$=-1,6855V **Absolute inverse** standard potential ;

$-E_{Ox}=-E^\circ_{H2O2Ox}+0{,}0591/2\bullet log([H_2O]^4/[H_2O_2]/[H_3O^+]^2)$=-1,6855+0,0591/2*log(55,3^4/10^(-7,36*2)/10^(-10))=-0,749 V;

$-E_{Ox}=-E^\circ_{H2O2Ox}+0.0591/2\bullet log([H_2O_2]*[H_3O^+]^2/[H_2O]^4)$= -1,6855+0.0591/2*lg(1*10^(-7.36*2)/55.3^4)= -2,3265 V

$[\mathbf{H_2O_2}]$=1 M; $[\mathbf{H_2O_2}]$=10^(-10) M; concentration $\mathbf{2H_2O_{2aq}=>O_{2aqua}+2H_2O}$;

$[\mathbf{H_2O_2}]=10^{\wedge(-10)}$ M; $\Delta\mathbf{G}_{\mathbf{eq}BioChem}=(\mathbf{E}^\circ_{\mathbf{Red}}-\mathbf{E}^\circ_{\mathbf{Ox}})*\mathbf{F}*\mathbf{n}$=(0,08227-0,749)*96485*2=(-1,236)*96485*2=**-128,7** $^{kJ}/_{mol}$ ;

$[\mathbf{H_2O_2}]$=1 M; $\Delta\mathbf{G}_{\mathbf{eq}BioChem}=(\mathbf{E}^\circ_{\mathbf{Red}}-\mathbf{E}^\circ_{\mathbf{Ox}})*\mathbf{F}*\mathbf{n}$=(-0,2132-2,3265)*96485*2=(-2,5397)*96485*2=**-490,1** $^{kJ}/_{mol}$ ;

$\Delta G_{Alberty}=G_{O2Biochem\_arteriaj}+2*G_{H2OBioChemistry}-2*G_{H2O2}$=**78,08+2*85,64-2*364,79=-480,22** $^{kJ}/_{mol}$;

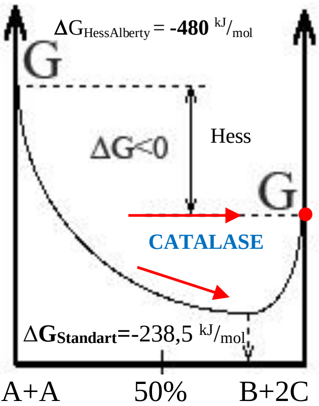
$\mathbf{2H_2O_{2(aq)}}$ $\mathbf{=>O_{2aqua}+2H_2O+Q+\Delta G}$; For activate homeostasis products, hydroxonium and peroxide anions: $G_{H2O2}$=364.8 $^{kJ}/_{mol}$; $G_{H3O+}+G_{HOO-}$=22.44+418.32=440.76 $^{kJ}/_{mol}$ free energy referring to water and $\mathbf{CO_{2}}_{gas}$ zero $G_{H2O}=G_{CO2gas}$=0 $^{kJ}/_{mol}$ appreciate values :

$\Delta G_{eqStandard}=(\mathbf{E}^\circ_{H2O2}-E^\circ_{H2O2Ox})*\mathbf{F}*\mathbf{n}$=(0,4495-1,6855)*96485*2=(-1,1845)*96485*2= **-238,5**....$^{kJ}/_{mol}$ ;

$\Delta G_{HessAlberty}=G_{O2}+2G_{H2O}-2G_{H2O2}$=330+2*(0)-(2***284**)=**-238** $^{kJ}/_{moll}$ ; **Alberty**

$\mathbf{K_{eqStandart}=K_{H2O2}=exp(-\Delta G_{eq}/R/T)}$=exp(238500/8.3144/298.15)=$10^{41,8}$........

Exothermic and exoergic $\mathbf{H_2O_2}$ (aq) dismutation Hesa free energy change $\Delta\mathbf{G}_{Alberty}$ is negative -**480**........ $^{kJ}/_{mol}$, but minimized $\Delta\mathbf{G}_{eqStandart}$**=-238.5**........$^{kJ}/_{mol}$ reaching equilibrium mixture constant $\mathbf{K_{eq}=10^{41,8}}$....... Le Chatelier principle is Prigogine attractor free energy change minimum $\Delta G_{min}$ reaching. High rate protolysis attractors pH=7.36, oxygen 20.95% in air stay at equilibrium, while Homeostasis irreversibly continues, as are non equilibrium state. Prigogine attractors Nobel Prize Chemistry 1977th. CATALASE erase peroxide molecules $\mathbf{H_2O_2}$ to 100% ω=6, ω=3 fatty acids C20:4 efficiency elongation synthesis in peroxisomes. CATALASE reactivity is indispensible irreversible Homeostasis Brownian molecular engine for evolution and survival.



reactants $\mathbf{2H_2O_{2(aq)}}$
products_$\mathbf{O_{2aqua}+2H_2O}$

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