CHEMISTRY 301 - FORMULA SHEET

General Formulas

$$\tau = \frac{M}{F} = \frac{1}{k}$$

$$\alpha_i = \frac{[X_i]}{\sum [X_i]}$$

$pH + pOH = pK_w$

$pH = - \log \{H^+\} \approx - \log [H^+]$

$pe = - \log \{e^-\} = E/0.0591$ at 25^oC

$\log \gamma_{DH} = -A\ z^2\ I^{1/2}$, where A = 0.51 at 25^oC

$I = 0.5 \Sigma\ c_i\ z_i^{\ 2}$

Fundamental Thermodynamic Relations

$\Delta G^o_{rxn} = \Sigma \Delta G^o_f$ (products) $- \Sigma \Delta G^o_f$(reactants)

$\Delta G_{rxn} = - n\ F\ E$ $\qquad$ $\Delta G_{rxn} = \Delta G^o_{rxn} + 2.303\ RT \log Q$

$$pe^o = \left(\frac{1}{n}\right) \log K \qquad pe^o = \left(\frac{1}{n}\right) \frac{-\Delta G^o}{2.303\ R\ T} \qquad pe^o = \frac{E^o}{0.0591}$$

$$\log K = \frac{-\Delta G^o}{2.303 RT} \qquad E = E^o - \frac{2.303\ R\ T}{n\ F} \log Q \qquad pe = pe^o - \left(\frac{1}{n_e}\right) \log Q$$

$$pe = pe^o - \frac{n_H}{n_e} pH - \frac{1}{n_e} \log \frac{\{reduced\}}{\{oxidized\}}$$

CHEMISTRY 301 - INFORMATION SHEET

Abbreviations:
ABS – alkyl benzene sulfonates
AOP – advanced oxidation process
BOD – biochemical oxygen demand
CEC – cation exchange capacity
COD – chemical oxygen demand
DO – dissolved oxygen
DDM – dimethyl mercury
EDTA – ethylenediamine tetraacetate
LAS – linear alkyl sulfonates
NTA – nitrilotriacetate
ORP – oxidation reduction potential
PCB – polychlorinated biphenyl
PCDD – polychlorinated dibenzodioxin
PCDF – polychlorinated dibenzofuran
SCE – saturated calomel electrode
SHE – standard hydrogen electrode
SSCE – saturated silver/silver chloride electrode
STP – sodium tripolyphosphate
TEL – tetraethyl lead
TOC – total organic carbon
ZPC – zero point charge

Conversions:

$$1\,\text{ppm} = \frac{1\,\text{mg}}{\text{kg}} = \frac{1\,\mu\text{g}}{\text{g}} = \frac{1\,\text{ng}}{\text{mg}} \qquad 1\,\text{ppb} = \frac{1\,\mu\text{g}}{\text{kg}} = \frac{1\,\text{ng}}{\text{g}}$$

1.00 atm = 101,300 Pa $1\ km^3 = 10^9\ m^3 = 10^{12}\ L$

Kelvin Temperature = 273.2 + ^oC

$E_h = E_{SCE} + 0.241\ V$ or $E_h = E_{SSCE} + 0.220\ V$

typical humics: ~ 60% C (by mass)
C_{FACO2-} ~ 5 mmol/g

Gas Composition of Dry Atmosphere

N_2	0.7801
O_2	0.2095
He	0.00980
CO_2	0.000365

CHEMISTRY 301 - DATA SHEET

Universal Constants

$R = 8.314\ J\ mol^{-1}\ K^{-1} = 0.08206\ L\ atm\ mol^{-1}\ K^{-1}$
$F = 96{,}480\ C\ mol^{-1}$ where, $1\ C = 1\ J/V$ and $1\ J = 1\ kg\ m^2\ s^{-2}$

Specific Constants

Autodissociation of water

$K_w = 1.0 \times 10^{-14}$

Henry's Law Constants

$K_H\ (O_2) = 1.3 \times 10^{-8}\ mol\ L^{-1}\ Pa^{-1}$
$K_H\ (CO_2) = 3.3 \times 10^{-7}\ mol\ L^{-1}\ Pa^{-1}$
$K_H\ (NH_3) = 5.7 \times 10^{-4}\ mol\ L^{-1}\ Pa^{-1}$
$K_H\ (O_3) = 1.3 \times 10^{-7}\ mol\ L^{-1}\ Pa^{-1}$

Acid Dissociation Constants

H_3PO_4	$K_{a1} = 7.1 \times 10^{-3}$	$K_{a2} = 6.3 \times 10^{-8}$	$K_{a3} = 4.2 \times 10^{-13}$
H_3T	$K_{a1} = 2.2 \times 10^{-2}$	$K_{a2} = 1.1 \times 10^{-3}$	$K_{a3} = 5.2 \times 10^{-11}$
H_2CO_3	$K_{a1} = 4.5 \times 10^{-7}$	$K_{a2} = 4.7 \times 10^{-11}$	
H_2S	$K_{a1} = 1.0 \times 10^{-7}$	$K_{a2} = 1.1 \times 10^{-12}$	
NH_4^+	$K_a = 5.6 \times 10^{-10}$		
HOCl	$K_a = 3.0 \times 10^{-8}$		

Solubility Product Constants

$K_{sp}\ (Ca_5(PO_4)_3OH) = 1.0 \times 10^{-56}$
$K_{sp}\ (Ca_3(PO_4)_2) = 2.2 \times 10^{-33}$
$K_{sp}\ (CaCO_3) = 6.0 \times 10^{-9}$
$K_{sp}\ (Fe(OH)_2) = 4.8 \times 10^{-17}$
$K_{sp}\ (Fe(OH)_3) = 1.0 \times 10^{-38}$
$K_{sp}\ (FePO_4) = 2.3 \times 10^{-18}$
$K_{sp}\ (Zn(OH)_2 = 1.2 \times 10^{-17}$
$K_{sp}\ (AlPO_4) = 1.0 \times 10^{-21}$

Standard Reduction Potentials

$O_2 + 4\ H^+ + e^- \rightarrow 2\ H_2O$	$E^o = 1.23\ V$
$MnO_2 + 4\ H^+ + 2\ e^- \rightarrow Mn^{2+} + 2\ H_2O$	$E^o = 1.23\ V$
$Fe(OH)_3 + e^- + 3\ H^+ \rightarrow Fe^{2+} + 3\ H_2O$	$E^o = 1.00\ V$
$NO_3^- + 10\ H^+ + 8\ e^- \rightarrow NH_4^+ + 3\ H_2O$	$E^o = 0.882\ V$
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	$E^o = 0.771V$
$SO_4^{2-} + 9H^+ + 8\ e^- \rightarrow HS^- + 4\ H_2O$	$E^o = 0.248\ V$
$CO_2 + 4\ H^+\ 4\ e^- \rightarrow \{CH_2O\} + H_2O$	$E^o = -0.07\ V$
$2\ H_2O + 2\ e^- \rightarrow H_2 + 2\ OH^-$	$E^o = -0.83\ V$

Equilibrium constants are supplied at 25°C unless otherwise noted