Physical constants, conversion factors, and useful equations

Physical Constants

R = 8.314 J mol^{-1} K^{-1}
=0.08206 L atmK^{-1} mol^{-1}
= 0.08314 L bar K^{-1} mol^{-1}
N_A = 6.022 x 10^{23} mol^{-1}
k_B = 1.381 x 10^{-23} J K^{-1}
h = 6.626 x 10^{-34} J s
F = 96,485 C mol^{-1}
c = 2.998 x 10^{8} m s^{-1}
g = 9.81 m s^{-2}
e = 1.6022 x 10^{-19} C
ε_o = 8.854 x 10^{-12} C^2 J^{-1} m^{-1}
B = 0.51 mol$^{-1/2}$ dm$^{3/2}$ (in H_2O, 25^{o}C)

Other Units

1dm^3 =1 L
1dm^3 =1000 cm^3
1 J = 1 kg m^2 s^{-2}
1 atm =1.01325 x 10^5 Pa
1 atm = 760 mmHg
1 Torr = 1 mmHg
1 Torr = 133.322 Pa
1 bar = 10^5 Pa
$E = h\upsilon$
$c = \upsilon\lambda$
$PV = nRT$
(RT)/F = 25.6926 mV at 25^{o}C
ln(x)/log$_{10}$(x) = 2.30259 for all x
ln(1 - θ) = -θ
if θ << 1
Quadratic equation:
a x^2 + b x + c = 0
solutions:
$x_{1,2}$ = (1/2a)[- b ± (b^2 - 4ac)$^{1/2}$]
RT/F = 25.70 mV(at 25^{o}C for ln)
= 59.16 mV(at 25^{o}C for log$_{10}$)
Michaelis - Menten equation:
$(1/R_0)=(1/R_{max}) + (K_m/R_{max})x(1/[S]_0)$
Lindemann mechanism:
$k_{uni} = k_1k_2[M](k_{-1}[M] + k_2)^{-1}$
Langmuir isotherm:
θ = KP/(1 + KP)
$1/R_o = 1/R_{max} + (K_m/R_{max})\,(1/[S]_o)$
Sequential reactions:

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

$[B]=(k_1/(k_2-k_{-1}))\, f(t)[A]_0$
$f(t)=\exp(-k_1t)-\exp(-k_2t)$

Important Equations

$$\Lambda = \frac{\kappa}{c}\ ,\ \alpha = \frac{\Lambda}{\Lambda_0} \quad \text{and} \quad I = \frac{1}{2}\sum_i c_i z_i^2$$

$$\log_{10}\gamma_i = -z_i^2 B\sqrt{I} \quad \text{and} \quad \log_{10}\gamma_{\pm} = -z_+ |z_-| B\sqrt{I}$$

$\Lambda_m = \Lambda^o_m - K\,(c/c_o)^{1/2}$ (strong)
$1/\Lambda_m = 1/\Lambda^o_m + c\Lambda_m /[(\Lambda^o_m)^2 K_a]$ (weak)
$\Delta G^o_{solvation} = (1/\varepsilon_r - 1)z^2e^2N_A/(8\pi\varepsilon_o r)$

$$E = E^o - \frac{RT}{zF}\ln\left(\frac{[Y]^y[Z]^z}{[A]^a[B]^b}\right)^u$$

$\Delta G = -nFE$ and thus $\Delta G^o = -nFE^o$
$\Delta S = nF(dE/dt)_P$
$a_\pm^{m+n} = a_+^m a_-^n$ for A_mB_n
$\kappa = [2e^2N_A \times (1000\ L\ m^{-3})/(\varepsilon_o k_B T)]^{1/2} \times [\rho_{solvent}\ I/\varepsilon_r]^{1/2}$
E^oAgCl/Ag = +0.222 V

$$k = A\ e^{-E_a/RT}$$

$$k = \frac{k_BT}{h}e^{-\Delta^{\neq}G^{\circ}/RT}$$

$E_a = \Delta^{\neq}H^o - P\Delta^{\neq}V^o + RT$ (sol)
$= \Delta^{\neq}H^o - \Sigma\nu RT + RT$ (gas)
$\Delta G^{\#} = \Delta H^{\#} - T\Delta S^{\#}$
$t_{1/2}$ = (ln 2)/k (1st order)
fluorescence lifetime $t_f = (k_f + k_q[Q])^{-1}$
$R_o = k_2[S]_o[E]_0/([S]_o + K_m)$,
$K_m = (k_{-1} + k_2)/k_1$
$k_2[E]_0 = R_{max} = V$
$D = (1/3)\, v_{ave}\, \lambda$
$\kappa = (1/3)\,(C_{V,m}/N_A)\, v_{ave}\, N_p\, \lambda$

$PV = nRT = (N/N_A)RT$,
$(C_{V,m}/N_A) = (3/2)\, k_B$
$\eta = (1/3)\, v_{ave}N_p\lambda m$
$f = 6\pi\eta r = k_BT/D$
$v_{ave} = (8RT/(\pi M))^{1/2}$
$N_p\lambda = 1/((\sqrt{2})\sigma)$,
$\lambda = RT/(PN_A(\sqrt{2})\sigma)$
$Np = (N/V) = PN_A/(RT)$
$\sigma = \pi d^2$
$x_{rms} = \sqrt{(2Dt)}$ (1-Dimension)

$r_{rms} = \sqrt{(6Dt)}$ (3-Dimension)
Poisseuille equation: $(\Delta V/\Delta t) = (\pi r^4/(8\eta))\, \Delta P/\Delta L$

Stokes-Einstein equation: $D = k_BT/(6\pi\,\eta r)$

if r(particle) >> r(solvent molecule)

Ostwald viscosimeter: $\eta = A\rho t$,

Capillary rise: $h = 2\gamma/(\rho g r)$

Note:
Quantum yield/efficiency = Φ = moles of product formed / moles of photons absorbed