CHEM 1523 Formula Sheet

<div style="border:1px solid">

Constants and conversion factors

$R = 62.36 \; \text{L} \cdot \text{torr} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$

$\quad = 0.08206 \; \text{L} \cdot \text{atm} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$

$\quad = 0.08314 \; \text{L} \cdot \text{bar} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$

$\quad = 8.314 \; \text{L} \cdot \text{kPa} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$

$\quad = 8.314 \; \text{J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$

$\quad = 8.314 \; \text{kg} \cdot \text{m}^{2} \cdot \text{s}^{-2} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$

$F = 96485 \; \text{C} \cdot \text{mol}^{-1}$

$\quad = 96485 \; \text{J} \cdot \text{mol}^{-1} \cdot \text{V}^{-1}$

$T(K) = T(°C) + 273.15$

1 atm = 101.325 kPa = 760 torr = exactly 760 mmHg

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$$PV = nRT \qquad \frac{P_f V_f}{n_f T_f} = \frac{P_i V_i}{n_i T_i} \qquad E_{\text{K, ave}} = (3/2)RT/N_A$$

$$u_{\text{rms}} = \sqrt{3RT/M} \qquad M = \frac{mRT}{PV} \qquad d = \frac{PM}{RT}$$

$$\frac{\text{rate (diffusion or effusion) of gas A}}{\text{rate diffusion or effusion of gas B}} = \sqrt{\frac{\text{molar mass of gas B}}{\text{molar mass of gas A}}}$$

$$\frac{\text{rate (diffusion or effusion) of gas A}}{\text{rate diffusion or effusion of gas B}} = \sqrt{\frac{\text{density of gas B}}{\text{density of gas A}}}$$

$$P_{\text{tot}} = P_A + P_B + \cdots \qquad x_A = \frac{n_A}{n_{\text{tot}}} = \frac{P_A}{P_{\text{tot}}} = \frac{V_A}{V_{\text{tot}}}$$

For a reaction $a\,\text{A} + b\,\text{B} \rightarrow c\,\text{C} + d\,\text{D}$,

$$\text{reaction rate} = k[\text{A}]^x[\text{B}]^y = -\frac{1}{a}\frac{\Delta[\text{A}]}{\Delta t} = -\frac{1}{b}\frac{\Delta[\text{B}]}{\Delta t} = \frac{1}{c}\frac{\Delta[\text{C}]}{\Delta t} = \frac{1}{d}\frac{\Delta[\text{D}]}{\Delta t}$$

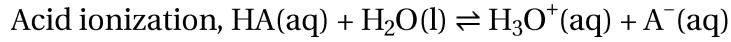$$k = Ae^{\frac{-E_a}{RT}} \qquad \ln k = \frac{-E_a}{R}\frac{1}{T} + \ln A \qquad \ln\left(\frac{k_2}{k_1}\right) = \frac{-E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

For first-order and pseudo first-order reactions,

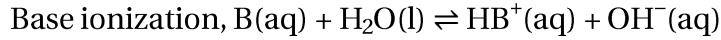$$\ln\frac{[\text{A}]}{[\text{A}]_0} = -kt \qquad \ln[\text{A}] = -kt + \ln[\text{A}]_0 \qquad t_{1/2} = \frac{0.693}{k}$$

Acid ionization, $HA(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + A^-(aq)$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]} \qquad pK_a = -\log K_a \qquad \% \text{ ionization} = \frac{[H_3O^+]_{eq}}{[HA]_{initial}} \times 100\%$$

Base ionization, $B(aq) + H_2O(l) \rightleftharpoons HB^+(aq) + OH^-(aq)$

$$K_b = \frac{[HB^+][OH^-]}{[B]} \qquad pK_b = -\log K_b \qquad \% \text{ ionization} = \frac{[OH^-]_{eq}}{[B]_{initial}} \times 100\%$$

$$pH = -\log[H_3O^+] \qquad [H_3O^+] = 10^{-pH} \qquad pOH = -\log[OH^-] \qquad [OH^-] = 10^{-pOH}$$

At 25 °C, $K_w = 1.0 \times 10^{-14}$ and $pK_w = 14.00$

$$K_w = 1.0 \times 10^{-14} = [H_3O^+][OH^-] \qquad K_w = 1.0 \times 10^{-14} = K_{a,\text{ conj acid}} \times K_{b,\text{ conj base}}$$

$$pK_w = 14.00 = pH + pOH \qquad pK_w = 14.00 = pK_{a,\text{ conj acid}} + pK_{b,\text{ conj base}}$$

$$pH = pK_a + \log\left(\frac{[A^-]}{[HA]}\right)$$

Dissolution of a sparingly soluble ionic compound

$$M_pX_q(s) \rightleftharpoons p\,M^{m+}(aq) + q\,X^{n-}(aq) \qquad\qquad K_{sp} = [M^{m+}]^p[X^{n-}]^q$$

$$\Delta U = q + w \qquad\qquad q = mc\Delta T \qquad\qquad w = -P\Delta V$$

At constant volume, $\Delta U = q$ $\qquad\qquad$ At constant pressure, $\Delta H = q$

$$\Delta H° = \sum n \times \Delta H°_f(\text{products}) - \sum n \times \Delta H°_f(\text{reactants})$$

$$\Delta S° = \sum n \times S°(\text{products}) - \sum n \times S°(\text{reactants})$$

$$\Delta G° = \sum n \times \Delta G°_f(\text{products}) - \sum n \times \Delta G°_f(\text{reactants})$$

$$\Delta G = \Delta H - T\Delta S \Rightarrow \text{at standard state, } \Delta G° = \Delta H° - T\Delta S°$$

$$\Delta G_r = \Delta G_r° + RT\ln Q \qquad\qquad \Delta G_r° = -RT\ln K \qquad\qquad K = e^{-\frac{\Delta G_r°}{RT}}$$

$$E°_{cell} = E°_{cathode} - E°_{anode}$$

$$E_{cell} = E°_{cell} - \frac{RT}{nF}\ln Q \qquad \Rightarrow \text{at 298.15 K,} \qquad E_{cell} = E°_{cell} - \frac{0.0592 \text{ V}}{n}\log Q$$

$$E°_{cell} = \frac{RT}{nF}\ln K \qquad \Rightarrow \text{at 298.15 K,} \qquad E°_{cell} = \frac{0.0592 \text{ V}}{n}\log K$$

$$\Delta G = -nFE_{cell} \qquad \Rightarrow \text{at standard state,} \qquad \Delta G° = -nFE°_{cell}$$