**CHEMISTRY**

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| **CONSTANTS/CONVERSTIONS** | **APPLICATION** |
| **R = 8.314 J mol-1 K-1** | Use this when pressure is in KPa or if formulas involve ΔG, ΔH, ΔS, Eo (or E) |
| **R = 0.0821 L atm mol-1 K-1** | Use this one when pressure is in atm or when converting between Kp and Kc |
| **∆T** | Is the same whether Celsius or Kelvin |
| $$K= ℃+273$$ | **K**  represents temperature in **KELVIN**You **must** use kelvin units unless calculating a ∆T (same in both units) |
| **Pressure units:** | **1 atm = 760 mmHg = 760 torr = 101,325 Pa = 101.325 KPa = 14.7 psi** |
| **Metric Prefixes** |

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| **Prefix** | **Symbol** | **S.N. equivalent** |
| Kilo | **K** | 1 Kilo = **1 x 103** base unit |
| Centi | **c** | 1 centi = **1 x 10─2** base unit |
| Milli | **m** | 1 milli = **1 x 10─3** base unit |
| Micro | **μ** | 1 **μ** (micro) = **1 x 10─6** base unit |
| Nano | **n** | 1 nano = **1 x 10─9** base unit |
| Angtrom | **Å** | 1 angstrom = **1 x 10─10** meters |
| Pico | **p** | 1 pico = **1 x 10─12** base unit |

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| **FORMULA** | **VARIABLES DEFINED** | **USE WHEN…** |
| $$E=hν$$ | **E** is energy in Joules**h** is Planck’s cst = 6.626 x 10─34 J s$ν$ is frequency in s ─1 or Hz | Calculating the energy or frequency of light emitted during relaxation (electron moves from higher energy level to lower energy level)May be used for absorption of energy, or excitation (electron moves from lower energy level to higher energy level) |
| $$E= \frac{hc}{λ}$$ | **E** is energy in Joules**h** is Planck’s cst = 6.626 x 10─34 J s**c** is the speed of light 3 x 108 m s ─1**λ** is the wavelength in meters | Calculating the energy or wavelength of light emitted during relaxation (electron moves from higher energy level to lower energy level)May be used for absorption of energy, or excitation (electron moves from lower energy level to higher energy level) |

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| $$c= λν$$ | **c** is the speed of light 3 x 108 m s ─1**λ** is the wavelength in meters$ν$ is frequency in s ─1 or Hz | Used to interconvert between frequency and wavelength of electromagnetic radiation |
| $$M= \frac{moles of solute}{Liters of solution}$$ | **M** is called the molarity – for aqueous solutions.  | The value is temperature **DE**pendent |
| $$m= \frac{moles of solute}{Kg of solvent}$$ | **m** is called the molality.  | The value is temperature **IN**dependent |
| $$X\_{A}= \frac{moles of A}{total moles in solution}$$ | **XA** is called the mole fraction | Used in Raoult’s law for calculating the vapor pressure for mixtures of miscible liquids. |
| $$K\_{c}= \frac{[C]^{c}[D]^{d}}{[A]^{a}[B]^{b}}$$ | For a generalized reaction:aA + bB $⇌$ cC + dD**Kc** is the equilibrium constant.Brackets indicate molarity (n/L) | Used when (1) reactions do not proceed 100% to completion and (2) the rate of the forward reaction is equal to the rate of the reverse reaction. |
| $$K\_{P}= \frac{P\_{C}^{c}x P\_{D}^{d}}{P\_{A}^{a}x P\_{B}^{b}}$$ | For a generalized reaction:aA + bB $⇌$ cC + dD**KP** is the equilibrium constant using partial pressures**Px** is the partial pressure of “x” | Equilibrium calculations when reactions do not go to completion. **D NOT** include solid (*s*) and liquids (*l*) |
| $$K\_{P}= K\_{C}(RT)^{∆n}$$ | **See above****R** = usually 0.0821**T** must be Kelvin$$∆n= \sum\_{}^{}coef for gaseous products- \sum\_{}^{}coef for gaseous reactants$$ |
| $$Q\_{P}= \frac{P\_{C}^{c}x P\_{D}^{d}}{P\_{A}^{a}x P\_{B}^{b}}$$ | **Q** is the same ratio as “K” but at non-equilibrium, or initial, conditions. | Use to determine (1)if a system is at equilibrium (2) which direction a reaction will proceed to achieve equilibrium (3) if a precipitate will form for slightly soluble salts |
| $$K\_{w}= \left[H^{+}\right]\left[OH^{-}\right]$$$$K\_{w}= \left[H\_{3}O^{+}\right]\left[OH^{-}\right]$$$$K\_{w}= 1 x 10^{-14} @ 25^{o}C$$ | **Kw** is the equilibrium constant for the auto-ionization of water2H2O $⇌$ H3O+ + OH─H+ is a proton and H3O+ is the hydronium ion and they are considered “symbolic synonyms”OH─ is the hydroxide ionBrackets indicate molarity (n/L) | **CAUTION: If not at 25oC, the Kw will be given and pH = 7 will not be neutral!**Neutral is defined as when $\left[H^{+}\right]= \left[OH^{-}\right] $ |
| $$pH= -log⁡\left[H\_{3}O^{+}\right]= -log⁡\left[H^{+}\right]$$$$pOH= -log⁡\left[OH^{-}\right]$$ | H+ is a proton and H3O+ is the hydronium ion and they are considered “symbolic synonyms”OH─ is the hydroxide ionBrackets indicate molarity (n/L) |
| $$14=pH+pOH @ 25^{o}C$$ | See above |  |
| $$pH= pK\_{a}+log\left(\frac{\left[Conj. Base\right]}{\left[Acid\right]}\right)$$$$pK\_{a}= -log⁡\left(K\_{a}\right)$$ | **Ka** is the equilibrium constant for the reaction of a weak acid with water**Conj. Base** is what is formed after the acid donates an H+. This is not given on the AP formula chart, but is a helpful formula for buffers. |
| $$pOH= pK\_{b}+log\left(\frac{\left[Conj. Acid\right]}{\left[Base\right]}\right)$$$$pK\_{b}= -log⁡\left(K\_{b}\right)$$ | **Kb** is the equilibrium constant for the reaction of a weak bases with water**Conj. Acid** is what is formed after the base accepts an H+. This is not given on the AP formula chart, but is a helpful formula for buffers. |
| **FORMULA** | **VARIABLES DEFINED** | **USE WHEN…** |
| $$K\_{a} x K\_{b}= K\_{w}$$$$pK\_{a}+ pK\_{b}= 14 @25^{o}C$$ | **See above** | Used for equilibrium problems involving (1) salts of conjugates and (2) at the equivalence point of a titration involving a weak acid or a weak base. |
| $$ln\left[A\right]\_{t}= -kt+ ln\left[A\right]\_{0}$$$$ln\left(\frac{\left[A\right]\_{t}}{\left[A\right]\_{0}}\right)= -kt$$ | **[A]t**  represents the molarity of a substance at a defined time, t.**[A]0**  represents the molarity of a substance at t = 0**k** is the proportionality constant called the **rate constant**. | For first order kinetics when Rate = k[A]1Make sure units of time and k match. |
| $$\frac{1}{\left[A\right]\_{t}}=kt+ \frac{1}{\left[A\right]\_{0}}$$ | **See above** | For second order kinetics when Rate = k[A]2Make sure units of time and k match. |
| $$t\_{^{1}/\_{2}}= \frac{0.693}{k}$$ | **t1/2** is the time required for half of a sample to reaction | For first order kinetics when Rate = k[A]1Make sure units of time and k match. |
| $$ln\left(\frac{k\_{2}}{k\_{1}}\right)=- \frac{E\_{a}}{R}\left(\frac{1}{T\_{2}}-\frac{1}{T\_{1}} \right)$$ | **“k”:** rate constants at different temperatures**Ea** is the activation energy. Must be in **JOULES****T** is the temperature in Kelvin**R** is the gas constant = **8.314** | A graph of **ln(k)** versus Temperature yields activation energy from the slope. |
| $$PV=nRT$$ | **P** is the pressure**V** is the volume in **liters****n** represents moles**R** is the ideal gas constant**T** is the temperature in **Kelvin** | For calculations involving ideal **gases**. Make sure you match units for P & R (will be given) |
| $$P\_{A}= X\_{A}∙P\_{total}$$ | **PA** is the partial pressure of “A”**XA** is the mole fraction of “A” | This is Dalton’s Law – use only for gases. |
| $$P\_{TOTAL}= P\_{A}+ P\_{B}+ P\_{C}+ ∙∙∙$$ | **PX** is the partial pressure of “X” | This is another form of Dalton’s Law – use only for gases. |
| $$KE= \frac{1}{2}mv^{2}$$ | **KE** is the kinetic energy in Joules**m** is the mass in Kg/molecule**v** is the velocity in meters/second | Used when comparing the effusion velocity for gases of different masses. |
| $$\frac{v\_{1}}{v\_{2}}= \sqrt[2]{\frac{M\_{2}}{M\_{1}}}$$ | **v** is the velocity (may see “r” for rate)***M*** is the molar mass | **Graham’s Law** – used to compare rate of effusion of two gases as the same temperature |
| $$A=abc OR A= εbc$$ | **A** is the absorbance**b** is the path length**ε** is the molar extinction coefficient | Beer’s law formula. Use for solutions that have a color, such as many transition metal ions.  |
| $$q=mcΔT$$ | **q** = the heat transferred**m** is the mass in grams**c** is the specific heat capacity in J g-1K-1**∆T** = final T – initial T in Kelvin or oC | **Watch the units for “c” sometimes they are in moles in which case “m” needs to be moles.** |
| $$ΔS^{o}= \sum\_{}^{}S\_{products}^{o} - \sum\_{}^{}S\_{reactants}^{o} $$ | **S** is the entropy and is a measure of the randomness, disorder, or freedom in a system. | **∆S = +** IS thermodynamically favorable (TF) (more disorder/freedom)**∆S = ─** is NOT thermodynamically favorable (less disorder/freedom) |
| $$ΔH^{o}= \sum\_{}^{}ΔH\_{products}^{o} - \sum\_{}^{}ΔH\_{reactants}^{o} $$ | **∆H** is the enthalpy, the heat exchanged at constant pressure. | **∆H= +** is NOT thermodynamically favorable **∆H = ─** IS thermodynamically favorable  |
| **FORMULA** | **VARIABLES DEFINED** | **USE WHEN…** |
| $$ΔG^{o}= \sum\_{}^{}ΔG\_{products}^{o} - \sum\_{}^{}ΔG\_{reactants}^{o} $$ | **∆G** is the free energy and is the energy available to do work. | **∆G = +** is NOT thermodynamically favorable (TF) (not spontaneous)**∆G = ─** IS thermodynamically favorable (spontaneous) |
| $$ΔG^{o}= ΔH^{o}-TΔS^{o}$$ | **See above** | **Watch units and signs!** All in Joules or all in KJ. T must be in Kelvin.**∆H +, ∆S +** is TF at High T**∆H -, ∆S -** is TF at Low T**∆H +, ∆S -** is **never** TF **∆H -, ∆S +** is **always** **TF**  |
| $$ΔG^{o}= -RTln(K)$$ | **See above, K is the equilibrium constant.** **∆G** must be in **JOULES****T** must be in **KELVIN****R** must be 8.314 | Shows the relationship between the extent of a reaction and whether or not it is thermodynamically favorable.**∆G negative, K >> 1, products favored****∆G positive, K << 1, reactants favored** |
| $$ΔG= -n\_{e}FE^{0}$$ | **∆G** must be in **JOULES****F** is Faraday’s cst**F =**  96,500 coulombs/mole electrons**Eo** is the standard reduction potential for the system in Volts.**ne** is the moles of electrons transferred | Eo is the **maximum** voltage obtained for spontaneous reactions (galvanic/voltaic cells)Eo is the **minimum** voltage required for non-spontaneous reactions (electrolytic cells) |
| $$I= \frac{q}{t}$$ | **I** is the current in C/sec**q** is the charge in coulombs**t** is the time in seconds | Can be used to determine time, amps, or mass during a plating process. |
| $$E= E^{o}- \frac{RT}{nF}ln⁡(Q)$$ | **E** is the potential at non-standard temperature, pressure, or molarity.**R** is the ideal gas constant, **8.314****n** is the moles of electrons transferred**F** 96,500 coulombs/mole electrons | Typically used to determine the cell potential when molarity value(s) ≠ 1 *M* |
| $$p= k\_{H}c$$ | **p** is the partial pressure of the gaseous solute above the solution, **c** is the concentration of the dissolved gas**kH** is a constant with the dimensions of pressure divided by concentration. | Henry’s Law – use when determining the changes in partial pressure of a solvent with a **gaseous** solute. |
| $$P\_{solution}= X\_{Solvent}P\_{solvent}$$ | **Psolution** is the partial pressure of a solution**Xsolvent** is the mole fraction of the **SOLVENT****Psolvent**is the partial pressure of the solvent at a given temperature. | Raoults law for **non-volatile** solutes |
| $$P\_{solution}= X\_{A}P\_{A}+X\_{B}P\_{B}$$ | **See above** | Raoults law for a two component mixture where both components are **volatile** |