# AP® CHEMISTRY EQUATIONS AND CONSTANTS, EFFECTIVE 2025

| UNIT SYMBOLS | |
|---|---|
| gram, | g |
| mole, | mol |
| liter, | L |
| meter, | m |
| second, | s |
| hertz, | Hz |
| atmosphere, | atm |
| millimeter of mercury, | mm Hg |
| degree Celsius, | °C |
| Kelvin, | K |
| joule, | J |
| volt, | V |
| coulomb, | C |
| ampere, | A |

| UNIT CONVERSIONS |
|---|
| 1 hertz = 1 $s^{-1}$ |
| 1 atm = 760 mm Hg = 760 torr |
| K = °C + 273.15 |
| 1 volt = $\frac{\text{1 joule}}{\text{1 coulomb}}$ |
| 1 ampere = $\frac{\text{1 coulomb}}{\text{1 second}}$ |

| METRIC PREFIXES | | |
|---|---|---|
| Factor | Prefix | Symbol |
| $10^9$ | giga | G |
| $10^6$ | mega | M |
| $10^3$ | kilo | k |
| $10^{-2}$ | centi | c |
| $10^{-3}$ | milli | m |
| $10^{-6}$ | micro | μ |
| $10^{-9}$ | nano | n |
| $10^{-12}$ | pico | p |

## ATOMIC STRUCTURE

$$E = h\nu$$

$$c = \lambda\nu$$

$$F_{coulombic} \propto \frac{q_1 q_2}{r^2}$$

$E$ = energy
$\nu$ = frequency
$\lambda$ = wavelength
$F$ = force
$q$ = charge
$r$ = separation

Planck's constant, $h = 6.626 \times 10^{-34}$ J s

Speed of light, $c = 2.998 \times 10^8$ m $s^{-1}$

Avogadro's number $= 6.022 \times 10^{23}$ $mol^{-1}$

## GASES, LIQUIDS, AND SOLUTIONS

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$PV = nRT$$

$$P_A = P_{total} \times X_A \text{, where } X_A = \frac{\text{moles A}}{\text{total moles}}$$

$$P_{total} = P_A + P_B + P_C + \ldots$$

$$n = \frac{m}{\boldsymbol{M}}$$

$$D = \frac{m}{V}$$

$$KE = \frac{1}{2}mv^2$$

$$M = \frac{n_{solute}}{L_{solution}}$$

$$A = \varepsilon bc$$

$P$ = pressure
$V$ = volume
$T$ = temperature
$n$ = number of moles
$X$ = mole fraction
$m$ = mass
$\boldsymbol{M}$ = molar mass
$D$ = density
$KE$ = kinetic energy
$v$ = velocity
$M$ = molarity
$A$ = absorbance
$\varepsilon$ = molar absorptivity
$b$ = path length
$c$ = concentration

Gas constant, $R = 8.314$ J $mol^{-1}$ $K^{-1}$
$= 0.08206$ L atm $K^{-1}$ $mol^{-1}$

STP = 273.15 K and 1.0 atm

Ideal gas at STP = 22.4 L $mol^{-1}$

## KINETICS

$$[A]_t - [A]_0 = -kt$$

$$\ln[A]_t - \ln[A]_0 = -kt$$

$$\frac{1}{[A]_t} - \frac{1}{[A]_0} = kt$$

$$t_{1/2} = \frac{0.693}{k}$$

$k$ = rate constant

$t$ = time

$t_{1/2}$ = half-life

## EQUILIBRIUM

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}, \text{ where } a\text{ A} + b\text{ B} \rightleftarrows c\text{ C} + d\text{ D}$$

$$K_p = \frac{(P_C)^c(P_D)^d}{(P_A)^a(P_B)^b}$$

$$K_w = [H_3O^+][OH^-] = 1.0 \times 10^{-14} \text{ at } 25°C$$

$$pK_w = 14 = pH + pOH \text{ at } 25°C$$

$$pH = -\log[H_3O^+], \qquad pOH = -\log[OH^-]$$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}, \qquad K_b = \frac{[OH^-][HB^+]}{[B]}$$

$$pK_a = -\log K_a, \qquad pK_b = -\log K_b$$

$$K_w = K_a \times K_b, \qquad pK_w = pK_a + pK_b$$

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

<u>Equilibrium Constants</u>

$K_c$ (molar concentrations)

$K_p$ (gas pressures)

$K_w$ (water)

$K_a$ (acid)

$K_b$ (base)

## THERMODYNAMICS/ELECTROCHEMISTRY

$$q = mc\Delta T$$

$$\Delta H^\circ_{reaction} = \sum \Delta H^\circ_{f\ products} - \sum \Delta H^\circ_{f\ reactants}$$

$$\Delta S^\circ_{reaction} = \sum S^\circ_{products} - \sum S^\circ_{reactants}$$

$$\Delta G^\circ_{reaction} = \sum \Delta G^\circ_{f\ products} - \sum \Delta G^\circ_{f\ reactants}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$= -RT \ln K$$

$$= -nFE^\circ$$

$$I = \frac{q}{t}$$

$$E_{cell} = E^\circ_{cell} - \frac{RT}{nF}\ln Q$$

$q$ = heat

$m$ = mass

$c$ = specific heat capacity

$T$ = temperature

$S^\circ$ = standard entropy

$H^\circ$ = standard enthalpy

$G^\circ$ = standard Gibbs free energy

$R$ = gas constant

$K$ = equilibrium constant

$n$ = number of moles of electrons

$E^\circ$ = standard potential

$I$ = current (amperes)

$q$ = charge (coulombs)

$t$ = time (seconds)

$Q$ = reaction quotient

Faraday's constant, $F$ = 96,485 coulombs / 1 mol $e^-$