# AP® CHEMISTRY EQUATIONS AND CONSTANTS

Throughout the exam the following symbols have the definitions specified unless otherwise noted.

| | | | |
|---|---|---|---|
| L, mL | = liter(s), milliliter(s) | mm Hg | = millimeters of mercury |
| g | = gram(s) | J, kJ | = joule(s), kilojoule(s) |
| nm | = nanometer(s) | V | = volt(s) |
| atm | = atmosphere(s) | mol | = mole(s) |

## ATOMIC STRUCTURE

$$E = h\nu$$
$$c = \lambda\nu$$

$E$ = energy
$\nu$ = frequency
$\lambda$ = wavelength

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$^{-1}$
Electron charge, $e = -1.602 \times 10^{-19}$ coulomb

## EQUILIBRIUM

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

$$K_p = \frac{(P_\text{C})^c(P_\text{D})^d}{(P_\text{A})^a(P_\text{B})^b}$$

$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$$

$$K_b = \frac{[\text{OH}^-][\text{HB}^+]}{[\text{B}]}$$

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

$$\text{pH} = -\log[\text{H}^+], \text{ pOH} = -\log[\text{OH}^-]$$

$$14 = \text{pH} + \text{pOH}$$

$$\text{pH} = \text{p}K_a + \log\frac{[\text{A}^-]}{[\text{HA}]}$$

$$\text{p}K_a = -\log K_a, \text{ p}K_b = -\log K_b$$

Equilibrium Constants

$K_c$ (molar concentrations)
$K_p$ (gas pressures)
$K_a$ (weak acid)
$K_b$ (weak base)
$K_w$ (water)

## KINETICS

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

$$\ln[\text{A}]_t - \ln[\text{A}]_0 = -kt$$

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

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

$k$ = rate constant
$t$ = time
$t_{1/2}$ = half-life

## GASES, LIQUIDS, AND SOLUTIONS

$$PV = nRT$$

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

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

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

$$\text{K} = °\text{C} + 273$$

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

$$KE_{molecule} = \frac{1}{2}mv^2$$

Molarity, $M$ = moles of solute per liter of solution

$$A = \varepsilon bc$$

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

Gas constant, $R = 8.314$ J mol$^{-1}$ K$^{-1}$
$= 0.08206$ L atm mol$^{-1}$ K$^{-1}$
$= 62.36$ L torr mol$^{-1}$ K$^{-1}$

1 atm = 760 mm Hg = 760 torr

STP = 273.15 K and 1.0 atm

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

## THERMODYNAMICS / ELECTROCHEMISTRY

$$q = mc\Delta T$$

$$\Delta S° = \sum S° \text{ products} - \sum S° \text{ reactants}$$

$$\Delta H° = \sum \Delta H_f° \text{ products} - \sum \Delta H_f° \text{ reactants}$$

$$\Delta G° = \sum \Delta G_f° \text{ products} - \sum \Delta G_f° \text{ reactants}$$

$$\Delta G° = \Delta H° - T\Delta S°$$
$$= -RT \ln K$$
$$= -nFE°$$

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

$$E_{cell} = E_{cell}° - \frac{RT}{nF}\ln Q$$

$q$ = heat
$m$ = mass
$c$ = specific heat capacity
$T$ = temperature
$S°$ = standard entropy
$H°$ = standard enthalpy
$G°$ = standard Gibbs free energy
$n$ = number of moles
$E°$ = standard reduction potential
$I$ = current (amperes)
$q$ = charge (coulombs)
$t$ = time (seconds)
$Q$ = reaction quotient

Faraday's constant, $F$ = 96,485 coulombs per mole of electrons

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$