

DO NOT DETACH FROM BOOK.

## PERIODIC TABLE OF THE ELEMENTS

|                           |                           |                            |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                          |                           |
|---------------------------|---------------------------|----------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|---------------------------|
| 1<br><b>H</b><br>1.008    |                           |                            |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                          | 2<br><b>He</b><br>4.00    |
| 3<br><b>Li</b><br>6.94    | 4<br><b>Be</b><br>9.01    |                            |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           | 9<br><b>F</b><br>19.00   | 10<br><b>Ne</b><br>20.18  |
| 11<br><b>Na</b><br>22.99  | 12<br><b>Mg</b><br>24.30  |                            |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           |                           | 17<br><b>Cl</b><br>35.45 | 18<br><b>Ar</b><br>39.95  |
| 19<br><b>K</b><br>39.10   | 20<br><b>Ca</b><br>40.08  | 21<br><b>Sc</b><br>44.96   | 22<br><b>Ti</b><br>47.90  | 23<br><b>V</b><br>50.94   | 24<br><b>Cr</b><br>52.00  | 25<br><b>Mn</b><br>54.94  | 26<br><b>Fe</b><br>55.85  | 27<br><b>Co</b><br>58.93  | 28<br><b>Ni</b><br>58.69  | 29<br><b>Cu</b><br>63.55  | 30<br><b>Zn</b><br>65.39  | 31<br><b>Ga</b><br>69.72  | 32<br><b>Ge</b><br>72.59  | 33<br><b>As</b><br>74.92  | 34<br><b>Se</b><br>78.96  | 35<br><b>Br</b><br>79.90 | 36<br><b>Kr</b><br>83.80  |
| 37<br><b>Rb</b><br>85.47  | 38<br><b>Sr</b><br>87.62  | 39<br><b>Y</b><br>88.91    | 40<br><b>Zr</b><br>91.22  | 41<br><b>Nb</b><br>92.91  | 42<br><b>Mo</b><br>95.94  | 43<br><b>Tc</b><br>(98)   | 44<br><b>Ru</b><br>101.1  | 45<br><b>Rh</b><br>102.91 | 46<br><b>Pd</b><br>106.42 | 47<br><b>Ag</b><br>107.87 | 48<br><b>Cd</b><br>112.41 | 49<br><b>In</b><br>114.82 | 50<br><b>Sn</b><br>118.71 | 51<br><b>Sb</b><br>121.75 | 52<br><b>Te</b><br>127.60 | 53<br><b>I</b><br>126.91 | 54<br><b>Xe</b><br>131.29 |
| 55<br><b>Cs</b><br>132.91 | 56<br><b>Ba</b><br>137.33 | 57<br><b>*La</b><br>138.91 | 72<br><b>Hf</b><br>178.49 | 73<br><b>Ta</b><br>180.95 | 74<br><b>W</b><br>183.85  | 75<br><b>Re</b><br>186.21 | 76<br><b>Os</b><br>190.2  | 77<br><b>Ir</b><br>192.2  | 78<br><b>Pt</b><br>195.08 | 79<br><b>Au</b><br>196.97 | 80<br><b>Hg</b><br>200.59 | 81<br><b>Tl</b><br>204.38 | 82<br><b>Pb</b><br>207.2  | 83<br><b>Bi</b><br>208.98 | 84<br><b>Po</b><br>(209)  | 85<br><b>At</b><br>(210) | 86<br><b>Rn</b><br>(222)  |
| 87<br><b>Fr</b><br>(223)  | 88<br><b>Ra</b><br>226.02 | 89<br><b>†Ac</b><br>227.03 | 104<br><b>Rf</b><br>(261) | 105<br><b>Db</b><br>(262) | 106<br><b>Sg</b><br>(266) | 107<br><b>Bh</b><br>(264) | 108<br><b>Hs</b><br>(277) | 109<br><b>Mt</b><br>(268) | 110<br><b>Ds</b><br>(271) | 111<br><b>Rg</b><br>(272) |                           |                           |                           |                           |                           |                          |                           |

|                    |                           |                           |                           |                          |                          |                           |                           |                           |                           |                           |                           |                           |                           |                           |
|--------------------|---------------------------|---------------------------|---------------------------|--------------------------|--------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| *Lanthanide Series | 58<br><b>Ce</b><br>140.12 | 59<br><b>Pr</b><br>140.91 | 60<br><b>Nd</b><br>144.24 | 61<br><b>Pm</b><br>(145) | 62<br><b>Sm</b><br>150.4 | 63<br><b>Eu</b><br>151.97 | 64<br><b>Gd</b><br>157.25 | 65<br><b>Tb</b><br>158.93 | 66<br><b>Dy</b><br>162.50 | 67<br><b>Ho</b><br>164.93 | 68<br><b>Er</b><br>167.26 | 69<br><b>Tm</b><br>168.93 | 70<br><b>Yb</b><br>173.04 | 71<br><b>Lu</b><br>174.97 |
| † Actinide Series  | 90<br><b>Th</b><br>232.04 | 91<br><b>Pa</b><br>231.04 | 92<br><b>U</b><br>238.03  | 93<br><b>Np</b><br>(237) | 94<br><b>Pu</b><br>(244) | 95<br><b>Am</b><br>(243)  | 96<br><b>Cm</b><br>(247)  | 97<br><b>Bk</b><br>(247)  | 98<br><b>Cf</b><br>(251)  | 99<br><b>Es</b><br>(252)  | 100<br><b>Fm</b><br>(257) | 101<br><b>Md</b><br>(258) | 102<br><b>No</b><br>(259) | 103<br><b>Lr</b><br>(262) |

## AP<sup>®</sup> CHEMISTRY EQUATIONS AND CONSTANTS

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

L, mL = liter(s), milliliter(s)  
 g = gram(s)  
 nm = nanometer(s)  
 atm = atmosphere(s)

mm Hg = millimeters of mercury  
 J, kJ = joule(s), kilojoule(s)  
 V = volt(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<sup>-1</sup>

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

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

### EQUILIBRIUM

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

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

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

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

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

$$= K_a \times K_b$$

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

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

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

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

#### Equilibrium Constants

$K_c$  (molar concentrations)

$K_p$  (gas pressures)

$K_a$  (weak acid)

$K_b$  (weak base)

$K_w$  (water)

### KINETICS

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

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

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

$k$  = rate constant

$t$  = time

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

**GASES, LIQUIDS, AND SOLUTIONS**

$$PV = nRT$$

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

$$P_{\text{total}} = P_A + P_B + P_C + \dots$$

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

$$K = ^\circ\text{C} + 273$$

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

$$KE \text{ per molecule} = \frac{1}{2}mv^2$$

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

$$A = abc$$

$P$  = pressure

$V$  = volume

$T$  = temperature

$n$  = number of moles

$m$  = mass

$M$  = molar mass

$D$  = density

$KE$  = kinetic energy

$v$  = velocity

$A$  = absorbance

$a$  = molar absorptivity

$b$  = path length

$c$  = concentration

Gas constant,  $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$

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

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

$$1 \text{ atm} = 760 \text{ mm Hg} = 760 \text{ torr}$$

$$\text{STP} = 273.15 \text{ K and } 1.0 \text{ atm}$$

**THERMODYNAMICS / ELECTROCHEMISTRY**

$$q = mc\Delta T$$

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

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

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

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

$$= -RT \ln K$$

$$= -nFE^\circ$$

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

$q$  = heat

$m$  = mass

$c$  = specific heat capacity

$T$  = temperature

$S^\circ$  = standard entropy

$H^\circ$  = standard enthalpy

$G^\circ$  = standard Gibbs free energy

$n$  = number of moles

$E^\circ$  = standard reduction potential

$I$  = current (amperes)

$q$  = charge (coulombs)

$t$  = time (seconds)

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

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