Moles (amounts of substance)

Mass

$$\text{moles} = \frac{\text{mass}}{\text{molar mass}}$$

moles = g
molar mass = g mol^{-1}

Solution

moles = concentration x volume

concentration = mol dm^{-3}
volume = dm^3

Gas

pV = nRT

p = pressure (Pa)   R = gas constant (8.31 J K^{-1} mol^{-1})
V = volume (m^3)   T = temperature (K)

Energy, Enthalpy and Entropy

Calorimetry

q = mcΔT

q = energy change   c = specific heat capacity (J g^{-1}K^{-1})
(J or kJ)   ΔT = temperature change (K or ^{o}C)

Bond Enthalpies

ΔH = ∑(bond energies of reactants) - ∑(bond energies of products)

ΔH = change in enthalpy (kJ mol^{-1}), bond enthalpies = kJ mol^{-1}

Enthalpy

$$\text{enthalpy} = \frac{\text{moles}}{\text{energy change (q)}}$$

enthalpy = kJ mol^{-1}
energy change (q) = kJ

Gibbs Free Energy

ΔG = ΔH - TΔS

ΔG = Gibbs Free Energy (kJ mol^{-1}) ΔH = enthalpy change (kJ mol^{-1})
*ΔS = entropy change (**kJ** K^{-1} mol^{-1}) T =temperature (K)*

ΔG = - *RT* ln K

R = gas constant (8.31 J K^{-1} mol^{-1})   K = rate constant
ln = natural logarithm   T =temperature (K)

Entropy

ΔS = ∑S°(products) - ∑S°(reactants)

ΔS = entropy change (J K^{-1} mol^{-1})
S^e = standard entropy (J K^{-1} mol^{-1})

ΔS$_{(Total)}$ = ΔS$_{(System)}$ + ΔS$_{(Surroundings)}$

ΔS = entropy change (J K^{-1} mol^{-1})
ΔS$_{System}$ = entropy change of reaction

$$\Delta S_{(Surroundings)} = \frac{-\Delta H}{T}$$

*ΔS$_{(Surroundings)}$ = entropy change of surroundings (**kJ** K^{-1} mol^{-1})*
ΔH = enthalpy change (kJ mol^{-1})
T = temperature (K)

Equilibrium

Equilibrium Constant K_c

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

For the equilibrium $aA + bB \rightleftharpoons cC + dD$
[ ] = concentration

Equilibrium Constant K_p

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

For the equilibrium $aA_{(g)} + bB_{(g)} \rightleftharpoons cC_{(g)} + dD_{(g)}$
P_x = partial pressure (Pa)

Rates of Reaction

Rate Equation

$$\text{rate} = k \times [A]^x[B]^y[C]^z$$

Rate = mol dm^{-3} s^{-1} , [ ] = concentration
x,y,z = orders with respect to A, B and C

Arrhenius Equation

$$k = Ae^{\frac{-E_a}{RT}}$$

k = rate constant   *E_a = activation energy (kJ mol^{-1})*
A = constant   *T = temperature*
e = base of natural log   *R = gas constant (8.31 J K^{-1} mol^{-1})*

$$\ln k = -\frac{E_a}{RT} + \ln A$$

ln = natural logarithm

Acids, Bases and pH

Acid Dissociation Constant K_a

$$K_a = \frac{[H^+_{(aq)}][A^-_{(aq)}]}{[HA_{(aq)}]}$$

For the weak acid dissociation $HA \rightleftharpoons H^+ + A^-$
[ ] = concentration
K_a = acid dissociation constant (mol dm^{-3})

pK_a

$$pK_a = -\log_{10}K_a$$

Ionic Product of Water K_w

$$K_w = [H^+_{(aq)}][OH^-_{aq}]$$

K_w = ionic product of water (mol^2 dm^{-6})
at 298K, K_w = 1.00 x 10^{-14} mol^2 dm^{-6}

pH

$$pH = -\log_{10}[H^+_{(aq)}]$$

$[H^+_{(aq)}]$ = concentration of $H^+_{(aq)}$

$$[H^+_{(aq)}] = 10^{-pH}$$

Electrochemistry

Electromotive Force E_{cell}

$$E_{cell} = E_{reduction} - E_{oxidation}$$

E_{cell} = EMF (electromotive force) of electrochemical cell (V)
$E_{reduction}$ = standard electrode potential of cathode
$E_{oxidation}$ = standard electrode potential of anode

Conditions for standard electrode potentials = 298K, 1 mol dm^{-3} and 100kPa

Chromatography

Retention Factor R_f

$$R_f = \frac{\text{Distance travelled by sample}}{\text{Solvent Front}}$$

R_f = no units
solvent front = distance travelled by solvent

Assorted

Atom Economy

$$\text{Atom Economy} = \frac{\text{relative formula mass of desired product}}{\text{relative formula mass of all reactants (sum of)}} \times 100$$

Percentage Yield

$$\text{Percentage Yield} = \frac{\text{actual yield}}{\text{theoretical mass}} \times 100$$

Relative Atomic Mass A_r

$$A_r = \frac{(\textbf{Isotope 1 } \text{mass} \times \text{\% abundance}) + (\textbf{Isotope 2 } \text{mass} \times \text{\% abundance})..}{\text{total \% abundance (100)}}$$

Dilution

$$V_i C_i = V_f C_f$$

V_i = initial volume
C_i = initial concentration

V_f = final volume (after dilution)
C_f = final concentration (after dilution)