



Moles (amounts of substance)

Mass $\text{moles} = \frac{\text{mass}}{\text{molar mass}}$ *moles = g*
molar mass = g mol⁻¹

Solution $\text{moles} = \text{concentration} \times \text{volume}$ *concentration = mol dm⁻³*
volume = dm³

Gas $pV = nRT$ *p = pressure (Pa) R = gas constant (8.31 J K⁻¹ mol⁻¹)*
V = volume (m³) T = temperature (K)

Energy, Enthalpy and Entropy

Calorimetry $Q = mc\Delta T$ *Q = energy change (J or kJ)* *c = specific heat capacity (J g⁻¹ K⁻¹)*
 ΔT = temperature change (K or °C)

Bond Enthalpies $\Delta H = \sum(\text{bond energies of reactants}) - \sum(\text{bond energies of products})$

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 $\Delta G = \Delta H - T\Delta S$ *ΔG = Gibbs Free Energy (kJ mol⁻¹) ΔH = enthalpy change (kJ mol⁻¹)*
 ΔS = entropy change (kJ K⁻¹ mol⁻¹) T = temperature (K)

$\Delta G = -RT \ln K$ *R = gas constant (8.31 J K⁻¹ mol⁻¹) K = rate constant*
ln = natural logarithm T = temperature (K)

Entropy $\Delta S = \sum S^\circ(\text{products}) - \sum S^\circ(\text{reactants})$ *ΔS = entropy change (J K⁻¹ mol⁻¹)*
 S° = standard entropy (J K⁻¹ mol⁻¹)

$\Delta S_{(\text{Total})} = \Delta S_{(\text{System})} + \Delta S_{(\text{Surroundings})}$ *ΔS = entropy change (J K⁻¹ mol⁻¹)*
 ΔS_{System} = entropy change of reaction

$\Delta S_{(\text{Surroundings})} = \frac{-\Delta H}{T}$ *$\Delta S_{(\text{Surroundings})}$ = 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 = $\text{mol dm}^{-3} \text{s}^{-1}$, [] = concentration
 x, y, z = orders with respect to A, B and C

Arrhenius Equation
$$k = A e^{\frac{-E_a}{RT}}$$
 k = rate constant E_a = activation energy (kJ mol^{-1})
 A = constant T = temperature
 e = base of natural log R = gas constant ($8.31 \text{ J K}^{-1} \text{ mol}^{-1}$)

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

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

Ionic Product of Water K_w
$$K_w = [H^+]_{(aq)} [OH^-]_{(aq)}$$
 K_w = ionic product of water ($\text{mol}^2 \text{ dm}^{-6}$)
at 298K, $K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$

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

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



Electrochemistry

Electromotive Force E_{cell}

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

E_{cell} = EMF (electromotive force) of electrochemical cell (V)

$E_{\text{reduction}}$ = standard electrode potential of cathode

$E_{\text{oxidation}}$ = 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

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

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)

