CLASS 12 CHEMISTRY — FORMULA SHEET

Chapter 3 : Chemical Kinetics (NCERT)

3.1 Rate of Reaction

Concept	Formula
Average rate	= ±(Δ[concentration]) ÷ Δt
Instantaneous rate	= ±(d[concentration]) ÷ dt
For aA + bB → cC + dD	rate = −(1/a)d[A]/dt = +(1/c)d[C]/dt
Units of rate	mol L^{-1} s^{-1}
Reactant rate sign	Negative (concentration decreases)
Product rate sign	Positive (concentration increases)

3.2 Rate Law & Order

Concept	Detail
Rate law	rate = k $[A]^x$ $[B]^y$ (x, y found experimentally)
Order of reaction	= x + y (sum of exponents)
Molecularity	Number of species in an elementary step (1, 2, 3)
Order vs molecularity	Order can be 0/fractional ; molecularity is a whole number
Rate constant (k)	Rate when all concentrations = 1 (specific rate)
Units of k (order n)	$(\text{mol } L^{-1})^{(1-n)}$ s^{-1}

3.3 Integrated Rate Equations

Order	Integrated Equation & Half-life
Zero order	$[A] = [A]_0 - kt$; $k = ([A]_0 - [A]) \div t$
Zero order half-life	$t_{1/2} = [A]_0 \div (2k)$
First order	$k = (2.303/t) \log([A]_0/[A])$
First order (alt form)	$\ln[A] = \ln[A]_0 - kt$
First order half-life	$t_{1/2} = 0.693 \div k$ (independent of concentration)
Units of k (zero order)	mol L^{-1} s^{-1}
Units of k (first order)	s^{-1} ($time^{-1}$)

3.4 Half-life & Special Cases

Concept	Formula
Half-life (general, order n)	$t_{1/2} \propto [A]_0^{(1-n)}$
Zero order: $t_{1/2}$	$\propto [A]_0$ (directly proportional)
First order: $t_{1/2}$	Constant (independent of concentration)

Concept	Formula
Pseudo first order	Reaction appears first order (one reactant in excess, e.g. hydrolysis)
Example	Hydrolysis of ester / sucrose inversion (water in excess)

3.5 Temperature Dependence — Arrhenius Equation

Concept	Formula
Arrhenius equation	$k = A\, e^{(-Ea/RT)}$
Logarithmic form	$\ln k = \ln A - (E_a \div RT)$
Two temperatures	$\log(k_2/k_1) = (E_a/2.303R)[(T_2-T_1)/(T_1T_2)]$
A = frequency factor	Total collision frequency (pre-exponential factor)
E_a = activation energy	Minimum energy needed for reaction
Temperature coefficient	Rate roughly doubles for every 10°C rise
Graph of ln k vs 1/T	Straight line ; slope = $-E_a/R$

3.6 Collision Theory & Catalysis

Concept	Detail
Collision frequency (Z)	Number of collisions per second per unit volume
Effective collisions	Need proper orientation + energy ≥ E_a
Rate (collision theory)	rate = $P\, Z\, e^{(-Ea/RT)}$ (P = steric/probability factor)
Threshold energy	= activation energy + average energy of reactants
Catalyst	Provides an alternate path with LOWER E_a
Catalyst effect	Speeds both forward & backward equally ; does not change ΔH or K

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Rate basics	Rate = $-(1/a)d[A]/dt$. Reactant: negative ; product: positive.
Order vs molecularity	Order: experimental, can be 0/fractional. Molecularity: whole number from mechanism.
First order	$k = (2.303/t)\log([A]_0/[A])$; $t½ = 0.693/k$ (concentration-independent).
Zero order	$[A] = [A]_0 - kt$; $t½ = [A]_0/2k$ (proportional to concentration).
Units of k	Zero: mol $L^{-1}s^{-1}$; First: s^{-1}. Units reveal the order.
Arrhenius	$k = Ae^{(-Ea/RT)}$. Higher T or lower Ea → faster reaction.
Rate doubles	Roughly doubles per 10°C rise (temperature coefficient ≈ 2).
Catalyst	Lowers Ea via a new path. Does NOT change ΔH or equilibrium constant.