# Class 12 Chemistry – Chemical Kinetics | Study Guide

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## 1. Theory in Simple Words with Visuals

### 1.1 What is Chemical Kinetics?

- **Definition:** Chemical kinetics studies **how fast a chemical reaction occurs** and the **factors affecting the speed** of reactions.
- **Analogy:** Imagine a **race between molecules**—some react fast, some slow. Kinetics tells us **who wins and why**.

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### 1.2 Important Terms

| Term | Meaning | Visual / Analogy |
|---|---|---|
| Reaction Rate | Change in concentration per unit time | How fast "molecules are racing" |
| Rate Law | Relation between rate & concentration | Rate = k[A]^m[B]^n |
| Order of Reaction | Sum of powers in rate law | Like "total speed factor" |
| Molecularity | Number of molecules colliding in a step | 1 = unimolecular, 2 = bimolecular |
| Activation Energy (Ea) | Minimum energy needed to react | "Energy hurdle" in a race |
| Catalyst | Speeds up reaction without being consumed | "Coach helping runners" |

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### 1.3 Factors Affecting Reaction Rate

- **Concentration** → More molecules → more collisions
- **Temperature** → Higher temp → faster molecules
- **Surface area** → More exposed area → faster reaction
- **Catalyst** → Lowers activation energy → faster reaction

**Visual:**

```
Reactants → Collision → Activation Energy → Products
```

### 1.4 Rate Law & Order

- **General Rate Law:**

$$\text{Rate} = k[A]^m[B]^n$$

- **Order of reaction (overall):** m + n
- **Units of k:** Depends on order
- **Analogy:** “Exponents show how strongly concentration affects speed”

### 1.5 Integrated Rate Equations

| Order | Rate Law | Integrated Form | Plot |
|---|---|---|---|
| 0 | Rate = k | $[A] = [A]_0 - kt$ | [A] vs t → straight line |
| 1 | Rate = k[A] | $\ln[A] = \ln[A]_0 - kt$ | ln[A] vs t → straight line |
| 2 | Rate = $k[A]^2$ | $1/[A] = 1/[A]_0 + kt$ | 1/[A] vs t → straight line |

**Mnemonic: “Zero straight, One ln, Two 1/A”**

### 1.6 Arrhenius Equation

- Describes **temperature effect on rate constant**:

$$k = Ae^{-E_a/RT}$$

- **A = frequency factor**, **Ea = activation energy**
- **Graph:** ln k vs 1/T → slope = -Ea/R

**Analogy:** Molecules need a “hurdle jump” to react; Ea is the hurdle height.

### 1.7 Collision Theory

- Molecules must **collide with proper orientation and energy ≥ Ea** to react.
- **Diagram:**

```
Molecule A + Molecule B → (Collision) → Products
```

## 2. Key Concepts & Formulas

| Concept | Formula / Fact | Mnemonic / Tip |
|---|---|---|
| Rate Law | Rate = k[A]^m[B]^n | Exponents = order of each reactant |
| Order | m + n | Total power in rate law |
| Zero-order | $[A] = [A]_0$ - kt | Straight line [A] vs t |
| First-order | $\ln[A] = \ln[A]_0$ - kt | ln[A] straight line |
| Second-order | $1/[A] = 1/[A]_0$ + kt | 1/[A] straight line |
| Half-life 1st order | t½ = 0.693/k | Only for 1st order |
| Arrhenius | k = Ae^(-Ea/RT) | ln k vs 1/T → slope = -Ea/R |

**Tip:** Use **color coding:** Green = easy formulas, Red = tricky ones, Blue = graphs.

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## 3. Solved Numerical Problems

### Example 1: Rate Constant from Half-Life

**Problem:** First-order reaction t½ = 20 min. Find k.
**Solution:**

$$t_{1/2} = 0.693/k \implies k = 0.693/20 = 0.03465 \text{ min}^{-1}$$

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### Example 2: Concentration vs Time

**Problem:** For zero-order reaction, $[A]_0$ = 0.1 M, k = 0.005 M/s, find [A] after 10 s.
**Solution:**

$$[A] = [A]_0 - kt = 0.1 - (0.005 \times 10) = 0.05 \text{ M}$$

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### Example 3: Arrhenius Equation

**Problem:** Ea = 50 kJ/mol, T = 300 K, A = $10^{12}$ $s^{-1}$. Find k.

$$k = Ae^{-Ea/RT} = 10^{12} e^{-50000/(8.314 \times 300)} \approx 0.14 \text{ s}^{-1}$$

**Tip:** Always convert Ea to J/mol when using R = 8.314 J/mol·K

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## 4. Previous Years' Board Questions (Solved)

- First-order & second-order kinetics problems (2016-2022)
- Half-life calculation (2017, 2019, 2021)
- Arrhenius equation numericals (2015, 2018)
- Rate law from experimental data (2016, 2020)

**Pattern:** Half-life and rate constant numericals are **frequently asked**.

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## 5. Quick Revision Notes / Important Points

- **Rate = k[A]^m[B]^n**
- **Order = m+n**, **Molecularity = colliding molecules**
- **Half-life:** t½ = 0.693/k (1st order)
- **Integrated forms:** 0 → [A], 1 → ln[A], 2 → 1/[A]
- **Arrhenius:** k = Ae^(-Ea/RT)

**Visual Flowchart:**

```
Chemical Kinetics
   ↓
Rate → Rate Law → Order
   ↓
Graphs → Zero / First / Second Order
   ↓
Half-life / Arrhenius / Collision Theory
```

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## 6. Predicted / Likely Questions

1. Zero, first, second-order rate problems
2. Half-life calculations
3. Arrhenius equation numericals
4. Rate law determination from data
5. Collision theory and activation energy diagram questions

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## 7. Exam Tips & Tricks

- Always check **reaction order** before applying formula
- Convert units carefully (t in seconds, Ea in J/mol)
- Use **graphs** to identify reaction order easily
- Shortcut: t½ = 0.693/k for first order saves calculation time

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## 8. Visual & Kid-Friendly Learning Style

- Use **race analogy** for reaction speed
- Color-code **graphs and formulas**
- Sketch **energy vs reaction coordinate** diagram for activation energy
- Picture **molecules colliding like tiny cars in a race**