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Chemical Kinetics — CBSE Class 12 Chemistry Chapter Test

FREE CHAPTER TEST · CLASS XII · CHEMISTRY (043) · PATTERN OF THE CBSE SAMPLE QUESTION PAPER 2026-27

TIME ALLOWED	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
1½ hours	37	17 (A 8 · B 3 · C 3 · D 1 · E 2)	

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 17 questions. All questions are compulsory.
2. This question paper is divided into five sections: A, B, C, D and E.
3. Section A (Q1–8) contains 6 multiple choice questions and 2 assertion-reason based questions of 1 mark each.
4. Section B (Q9–11) contains short answer questions of 2 marks each.
5. Section C (Q12–14) contains short answer questions of 3 marks each.
6. Section D (Q15) contains case-based questions of 4 marks each, with sub-parts of 1, 1 and 2 marks.
7. Section E (Q16–17) contains long answer questions of 5 marks each.
8. There is no overall choice. However, an internal choice has been provided in 1 question in Section B, 1 question in Section C, 1 question in Section D, 2 questions in Section E. Attempt only one of the alternatives in such questions.
9. Use of log tables and calculators is not allowed. You may use: $R = 8.314\ J\ K^{-1}\ mol^{-1}$, log 2 = 0.3010, log 3 = 0.4771, log 4 = 0.6021.
10. This chapter test follows the section structure, question types and marks per question of the CBSE Class XII Chemistry (043) Sample Question Paper 2026-27, at about half the length of the 70-mark board paper: 37 marks in 1½ hours.
11. The answer key and the marking scheme are at the end of this booklet. Attempt the paper in 1½ hours before you look at them.

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Chapter: Chemical Kinetics · **Topics:** Rate of reaction and rate law · Order and molecularity · Integrated rate equations and half-life · Pseudo first-order reactions · Temperature dependence and Arrhenius equation · Collision theory

SECTION A

This section comprises 8 questions of 1 mark each: 6 multiple choice questions (MCQs) and 2 assertion-reason based questions.

1. The unit of the rate constant of a second-order reaction is 1

(A) s^{-1} (B) mol L^{-1} s^{-1}

(C) mol^2 L^{-2} s^{-1} (D) mol^{-1} L s^{-1}

2. The rate constant of a first-order reaction is 0.0693 min^{-1}. Its half-life is 1

(A) 1 min (B) 10 min

(C) 100 min (D) 0.1 min

3. The half-life of a zero-order reaction is 1

(A) independent of the initial concentration (B) inversely proportional to the initial concentration

(C) directly proportional to the initial concentration (D) proportional to the square of the initial concentration

4. For a reaction with rate = $k[A][B]^2$, if the concentration of B is doubled (A unchanged), the rate becomes 1

(A) 4 times (B) 2 times

(C) 8 times (D) unchanged

5. A catalyst increases the rate of a reaction by 1

(A) increasing the enthalpy change of the reaction (B) increasing the activation energy

(C) providing a path of lower activation energy (D) shifting the equilibrium towards the products

6. For a reaction with rate = $k[A]^{1/2}[B]$, the overall order is 1

(A) 1 (B) 1.5

(C) 2 (D) 0.5

7. **Assertion (A) :** The rate of most reactions increases when the temperature is raised. 1
Reason (R) : At a higher temperature, a larger fraction of the colliding molecules has energy equal to or greater than the activation energy.

(A) Both A and R are true, and R is the correct explanation of A.

(B) Both A and R are true, and R is not the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

8. **Assertion (A) :** The molecularity of a reaction can be zero or a fraction. 1
Reason (R) : The order of a reaction is determined experimentally.

(A) Both A and R are true, and R is the correct explanation of A.

(B) Both A and R are true, and R is not the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

SECTION B

This section comprises 3 short answer questions of 2 marks each.

9. The half-life of a first-order reaction is 30 min. Find its rate constant and the time taken for 75 % of the reaction to be completed. 2

10. (a) Give two differences between the order and the molecularity of a reaction. 2

OR

(b) What is a pseudo first-order reaction? Explain with one example.

11. A zero-order reaction has a rate constant of 2.0×10^{-3} mol L^{-1} s^{-1}. If the initial concentration of the reactant is 0.10 mol L^{-1}, find the half-life and the time for the reaction to be complete. 2

SECTION C

This section comprises 3 short answer questions of 3 marks each.

12. (a) Derive the integrated rate equation for a first-order reaction R → P. Hence show that its half-life does not depend on the initial concentration. 3

OR

(b) In a first-order reaction, the concentration of the reactant falls from 0.80 M to 0.10 M in 30 minutes. Find the half-life, the rate constant, and the time from the start at which the concentration will be 0.05 M.

13. For the reaction A + B → products, the following initial rates were measured at a fixed temperature: 3

Experiment 1: [A] = 0.10 M, [B] = 0.10 M, rate = 2.0×10^{-3} mol L^{-1} s^{-1}

Experiment 2: [A] = 0.20 M, [B] = 0.10 M, rate = 4.0×10^{-3} mol L^{-1} s^{-1}

Experiment 3: [A] = 0.20 M, [B] = 0.20 M, rate = 1.6×10^{-2} mol L^{-1} s^{-1}

Find the order with respect to A and to B, write the rate law and find the rate constant.

14. The rate constant of a reaction becomes three times larger when the temperature is raised from 300 K to 320 K. Find its activation energy. (R = 8.314 J K^{-1} mol^{-1}; log 3 = 0.4771) 3

SECTION D

This section comprises 1 case-based question of 4 marks, with sub-parts of 1, 1 and 2 marks.

15. The active ingredient of a medicine slowly decomposes, and the medicine is usually labelled as expired when 10 % of it has decomposed. For a certain tablet, the decomposition is first order with a rate constant of 5.0×10^{-3} per month at 25 °C. Many medicines carry the instruction 'Store in a cool place'. (log 9 = 0.9542; log 2 = 0.3010)

(I) Why does the time for 10 % of the medicine to decompose not depend on how much medicine there is in the pack? [1]

(II) Why does storing a medicine in a cool place make it last longer? [1]

(III) Find the shelf life of the tablet, that is, the time for 10 % of the ingredient to decompose at 25 °C. [2]

OR

(III) Find the half-life of the ingredient at 25 °C, and the fraction of it left after two half-lives. [2]

SECTION E

This section comprises 2 long answer questions of 5 marks each.

16. (a) (i) Write the Arrhenius equation, explaining each term. How can the activation energy be found from a graph of log k against 1/T? 5

(ii) Explain, using an energy diagram (described in words), how a catalyst increases the rate of a reaction.

(iii) The rate constant of a reaction is ten times larger at 500 K than at 400 K. Find its activation energy. ($R = 8.314\ J\ K^{-1}\ mol^{-1}$)

OR

(b) (i) Explain the collision theory of reaction rates. What are effective collisions?

(ii) Distinguish between threshold energy and activation energy.

(iii) The rate constant of a reaction becomes four times larger when the temperature rises from 300 K to 360 K. Find its activation energy. ($R = 8.314\ J\ K^{-1}\ mol^{-1}$; log 4 = 0.6021)

17. (a) (i) Derive the integrated rate equation for a zero-order reaction R → P. Describe the graph of [R] against t, and find the half-life. 5

(ii) The decomposition of ammonia on a hot platinum surface, $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$, is a zero-order reaction with rate constant $4.0 \times 10^{-4}\ mol\ L^{-1}\ s^{-1}$. Find the rates of formation of N_2 and of H_2.

OR

(b) (i) Show that for a first-order reaction the time needed for 99.9 % of the reaction to take place is about 10 times its half-life. (log 2 = 0.3010)

(ii) The first-order gas-phase reaction $A(g) \rightarrow B(g) + C(g)$ is started with pure A at a pressure of 0.40 atm. After 100 s the total pressure is 0.60 atm (constant volume and temperature). Find the rate constant.

END OF THE QUESTION PAPER

ANSWER KEY — SECTION A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
(D)	(B)	(C)	(A)	(C)	(B)	(A)	(D)

MARKING SCHEME AND WORKED SOLUTIONS

Marks for each step are shown in brackets, as in the CBSE marking scheme. Any correct alternative method earns full marks.

Q1. Answer (D). k = rate/[A]²: (mol L⁻¹ s⁻¹)/(mol L⁻¹)² = mol⁻¹ L s⁻¹.

Q2. Answer (B). $t_{½}$ = 0.693/k = 0.693/0.0693 = 10 min.

Q3. Answer (C). $t_{½} = [R]_0/2k$.

Q4. Answer (A). Rate ∝ [B]²: 2² = 4.

Q5. Answer (C). It gives an alternative path with a lower activation energy; ΔH and the equilibrium position are unchanged.

Q6. Answer (B). ½ + 1 = 1.5.

Q7. Answer (A). The fraction with $E \geq E_a$ (proportional to $e^{-E_a/RT}$) rises steeply with T. R explains A. Answer A.

Q8. Answer (D). Molecularity is the number of species colliding in an elementary step: always a whole number, never zero. A is false; R is true. Answer D.

Q9. (2 marks) Answer: 0.0231 min⁻¹; 60 min.
k = 0.693/30 = 0.0231 min⁻¹. [1]
75 % completed means 25 % left = two half-lives: t = 2 × 30 = 60 min. [1]

Q10. (2 marks) Answer: (a) any two differences; (b) one reactant in large excess.
(a) Any two [2]: order is found experimentally, molecularity is theoretical; order can be zero or fractional, molecularity is always a whole number (1, 2 or 3); order applies to the overall reaction, molecularity only to an elementary step; order is the sum of the powers in the rate law, molecularity the number of species colliding in an elementary step.
OR (b) A reaction whose true order is higher but which behaves as first order because one reactant is in large excess. [1] E.g. the acid hydrolysis of ethyl ethanoate: $CH_3COOC_2H_5 + H_2O \rightarrow CH_3COOH + C_2H_5OH$; water is in such excess that its concentration hardly changes, so rate = k′[ester]. [1]

Q11. (2 marks) Answer: 25 s; 50 s.
$t_{½} = [R]_0/2k = 0.10/(4.0 \times 10^{-3}) = 25$ s. [1]
$[R] = [R]_0 - kt = 0$ when $t = [R]_0/k = 50$ s. [1]

Q12. (3 marks) Answer: (a) $k = (2.303/t)\log([R]_0/[R])$; $t_{½} = 0.693/k$; (b) 0.0693 min⁻¹; 40 min.
(a) −d[R]/dt = k[R], so d[R]/[R] = −k dt. [1]
Integrating from $[R]_0$ at t = 0: $\ln([R]/[R]_0) = -kt$, i.e. $k = (2.303/t)\log([R]_0/[R])$. [1]
At $t_{½}$, $[R] = [R]_0/2$: $t_{½} = (2.303/k)\log 2 = 0.693/k$, with no $[R]_0$ in it. [1]
OR (b) 0.80 → 0.10 M is a fall to one-eighth = three half-lives, so $t_{½}$ = 30/3 = 10 min. [1]
k = 0.693/10 = 0.0693 min⁻¹. [1]
0.05 M is one-sixteenth: four half-lives = 40 min. [1]

Q13. (3 marks) Answer: order 1 in A, 2 in B; rate = k[A][B]²; k = 2.0 L² mol⁻² s⁻¹.
Exp. 1 → 2: [A] doubled, rate doubled: first order in A. [1]
Exp. 2 → 3: [B] doubled, rate four times: second order in B. Rate = k[A][B]². [1]
$k = 2.0 \times 10^{-3}/(0.10 \times 0.10^2) = 2.0$ L² mol⁻² s⁻¹. [1]

Q14. (3 marks) Answer: ≈ 43.8 kJ mol⁻¹.

$\log(k_2/k_1) = (E_a/2.303R)(T_2 - T_1)/(T_1T_2)$. [1]

$0.4771 = (E_a/(2.303 \times 8.314)) \times 20/(300 \times 320)$. [1]

$E_a = 0.4771 \times 2.303 \times 8.314 \times 4800 \approx 43\,800$ J mol⁻¹ ≈ 43.8 kJ mol⁻¹. [1]

Q15. (4 marks) Answer: (I) first order; (II) lower k; (III) ≈ 21 months, or ≈ 139 months and 25 %.

(I) For a first-order reaction, the time for a given fraction to react, $t = (2.303/k)\log([R]_0/[R])$, depends only on the ratio $[R]_0/[R]$, not on $[R]_0$. [1]

(II) A lower temperature lowers the rate constant (fewer molecules have the activation energy), so the decomposition is slower. [1]

(III) $t = (2.303/k)\log(100/90) = (2.303/5.0 \times 10^{-3}) \times (1 - 0.9542)$ [1] $= 460.6 \times 0.0458 \approx 21$ months. [1]

OR (III) $t_{½} = 0.693/5.0 \times 10^{-3} \approx 139$ months. [1] After two half-lives one-quarter (25 %) is left. [1]

Q16. (5 marks) Answer: (a) $k = A\,e^{-E_a/RT}$; slope $-E_a/2.303R$; ≈ 38.3 kJ mol⁻¹; (b) effective collisions; ≈ 20.8 kJ mol⁻¹.

(a) (i) $k = A\,e^{-E_a/RT}$: A is the Arrhenius (frequency) factor, E_a the activation energy, R the gas constant, T the absolute temperature. [1] $\log k = \log A - E_a/(2.303RT)$: a straight line of slope $-E_a/2.303R$, so $E_a = -2.303R \times$ slope. [1]

(ii) The energy of the reactants and of the products is unchanged (so ΔH is unchanged), but the peak (activated complex) of the catalysed path is lower: a smaller E_a means many more molecules can react. [1]

(iii) $\log 10 = 1 = (E_a/2.303R)(500 - 400)/(400 \times 500)$. [1] $E_a = 2.303 \times 8.314 \times 2000 \approx 38\,300$ J mol⁻¹ ≈ 38.3 kJ mol⁻¹. [1]

OR (b) (i) Molecules must collide to react; the rate = $P\,Z_{AB}\,e^{-E_a/RT}$, where Z_{AB} is the collision frequency. [1] Only collisions with energy at least equal to the threshold energy and with the proper orientation (the steric factor P) are effective. [1]

(ii) Threshold energy: the least energy colliding molecules must have to react; activation energy = threshold energy − the average energy of the reactants. [1]

(iii) $\log 4 = 0.6021 = (E_a/2.303R) \times 60/(300 \times 360)$. [1] $E_a = 0.6021 \times 2.303 \times 8.314 \times 1800 \approx 20\,800$ J mol⁻¹ ≈ 20.8 kJ mol⁻¹. [1]

Q17. (5 marks) Answer: (a) $[R] = [R]_0 - kt$; $t_{½} = [R]_0/2k$; 4.0×10^{-4} and 1.2×10^{-3} mol L⁻¹ s⁻¹; (b) ≈ 10 $t_{½}$; 6.93×10^{-3} s⁻¹.

(a) (i) $-d[R]/dt = k[R]^0 = k$, so $d[R] = -k\,dt$; integrating from $[R]_0$: $[R] = [R]_0 - kt$. [1½] The graph of [R] against t is a straight line of slope −k and intercept $[R]_0$. [½] At $t_{½}$, $[R] = [R]_0/2$: $t_{½} = [R]_0/2k$. [1]

(ii) Rate = $-½\,d[NH_3]/dt = d[N_2]/dt = ⅓\,d[H_2]/dt = k$. [1] $d[N_2]/dt = 4.0 \times 10^{-4}$ and $d[H_2]/dt = 1.2 \times 10^{-3}$ mol L⁻¹ s⁻¹. [1]

OR (b) (i) $t = (2.303/k)\log([R]_0/[R])$. For 99.9 %, $[R]_0/[R] = 1000$: $t = (2.303/k) \times 3$. [1½] $t_{½} = (2.303/k)\log 2 = (2.303/k) \times 0.3010$. [½] Ratio = 3/0.3010 ≈ 10. [1]

(ii) A → B + C: if p of A falls by x, the total = $p_0 + x$, so $p_A = 2p_0 - p_t = 0.80 - 0.60 = 0.20$ atm. [1] Half of A has gone in 100 s, so $t_{½} = 100$ s and $k = 0.693/100 = 6.93 \times 10^{-3}$ s⁻¹. [1]

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