



Chemical Kinetics — NEET (UG) Pattern Chapter Test

FREE CHAPTER TEST · CHEMISTRY · PATTERN OF NEET (UG)

DURATION	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
30 minutes	120	30	

GENERAL INSTRUCTIONS

1. This question paper has THIRTY (30) multiple-choice questions. All questions are compulsory.
2. Each question has FOUR options, (1), (2), (3) and (4), of which ONLY ONE is correct.
3. Marking scheme: +4 for a correct answer, -1 for an incorrect answer, 0 if the question is not attempted.
4. Take $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$, $\ln 2 = 0.693$, $\log 2 = 0.301$, $\log 3 = 0.477$ and $\log 5 = 0.699$. Use of a calculator, log tables or any other aid is not allowed.
5. The answer key and worked solutions are at the end of this booklet. Attempt the paper in 30 minutes before you look at them.

All questions are original and © Master Testing Agency. Free to download and use for personal practice; not for resale. Master Testing Agency is an independent test-prep publisher, not affiliated with, endorsed by or connected to the National Testing Agency (NTA) or any other exam-conducting body.

Topics covered: Rate of a reaction · Rate law and order · Molecularity and mechanism · Integrated rate equations · Half-life · Pseudo first-order reactions · Temperature dependence and Arrhenius equation · Activation energy and catalysis · Collision theory

CHEMISTRY (Q1–30) · Multiple choice · +4 / 0 / –1

Each question has FOUR options. ONLY ONE of them is correct.

1. Dinitrogen tetroxide decomposes in a closed vessel at constant temperature: $\text{N}_2\text{O}_4(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$. Starting with pure N_2O_4 , the total pressure rises from 0.50 atm to 0.56 atm in the first 30 s. The average rate of disappearance of N_2O_4 over this interval, in terms of its partial pressure, is

- (1) $0.06 \text{ atm min}^{-1}$
- (2) $0.24 \text{ atm min}^{-1}$
- (3) $0.12 \text{ atm min}^{-1}$
- (4) $2.0 \times 10^{-3} \text{ atm min}^{-1}$

2. The rate law of the reaction $\text{A} + \text{B} \rightarrow \text{products}$ is $\text{rate} = k[\text{A}]^{1/2}[\text{B}]$. If concentrations are in mol L^{-1} and time in s, the units of k are

- (1) $\text{mol}^{(-1/2)} \text{L}^{(1/2)} \text{s}^{-1}$
- (2) $\text{mol}^{(1/2)} \text{L}^{(-1/2)} \text{s}^{-1}$
- (3) $\text{mol}^{(-3/2)} \text{L}^{(3/2)} \text{s}^{-1}$
- (4) $\text{L mol}^{-1} \text{s}^{-1}$

3. The following initial rates were measured for the reaction $\text{A} + \text{B} \rightarrow \text{products}$ at a fixed temperature.

Experiment 1: $[\text{A}] = 0.10 \text{ M}$, $[\text{B}] = 0.10 \text{ M}$, initial rate = $2.0 \times 10^{-3} \text{ M s}^{-1}$

Experiment 2: $[\text{A}] = 0.20 \text{ M}$, $[\text{B}] = 0.10 \text{ M}$, initial rate = $8.0 \times 10^{-3} \text{ M s}^{-1}$

Experiment 3: $[\text{A}] = 0.20 \text{ M}$, $[\text{B}] = 0.40 \text{ M}$, initial rate = $1.6 \times 10^{-2} \text{ M s}^{-1}$

The initial rate (in M s^{-1}) when $[\text{A}] = 0.30 \text{ M}$ and $[\text{B}] = 0.90 \text{ M}$ is

- (1) 1.8×10^{-2}
- (2) 2.7×10^{-2}
- (3) 1.6×10^{-1}
- (4) 5.4×10^{-2}

4. For the decomposition of a substance A, the half-life is 200 s when the initial concentration of A is 0.10 mol L^{-1} and 50 s when it is 0.40 mol L^{-1} . The order of the reaction and its rate constant are

- (1) 1; $3.5 \times 10^{-3} \text{ s}^{-1}$
- (2) 2; $5.0 \times 10^{-2} \text{ L mol}^{-1} \text{s}^{-1}$
- (3) 0; $2.5 \times 10^{-4} \text{ mol L}^{-1} \text{s}^{-1}$
- (4) 2; $2.0 \times 10^{-2} \text{ L mol}^{-1} \text{s}^{-1}$

5. Two first-order reactions, $\text{A} \rightarrow \text{products}$ (half-life 10 min) and $\text{B} \rightarrow \text{products}$ (half-life 40 min), start at the same instant with $[\text{A}]_0 = 4[\text{B}]_0$. The concentrations of A and B become equal after

- (1) 20 min
- (2) 26.7 min
- (3) 40 min
- (4) 13.3 min

6. In a first-order reaction, the concentration of the reactant falls from 0.80 mol L^{-1} to 0.20 mol L^{-1} in 40 min. The time it takes to fall further from 0.20 mol L^{-1} to 0.025 mol L^{-1} is
- (1) 30 min
 - (2) 40 min
 - (3) 80 min
 - (4) 60 min
7. In a zero-order reaction, the concentration of the reactant falls from 0.80 mol L^{-1} to 0.50 mol L^{-1} in 15 min. The half-life of the reaction when the initial concentration is 0.60 mol L^{-1} , and the time for complete reaction starting from 0.80 mol L^{-1} , are
- (1) 15 min and 40 min
 - (2) 20 min and 40 min
 - (3) 15 min and 80 min
 - (4) 34.7 min and 40 min
8. The rate constant of a reaction doubles when the temperature is raised from 300 K to 310 K. The activation energy of the reaction is about ($R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)
- (1) 26.8 kJ mol^{-1}
 - (2) 107 kJ mol^{-1}
 - (3) 53.6 kJ mol^{-1}
 - (4) 5.4 kJ mol^{-1}
9. For a reaction, a plot of $\log_{10} k$ against $1/T$ is a straight line of slope -2500 K . The activation energy of the reaction is about ($R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)
- (1) 20.8 kJ mol^{-1}
 - (2) 2.5 kJ mol^{-1}
 - (3) 4.79 kJ mol^{-1}
 - (4) 47.9 kJ mol^{-1}
10. A catalyst lowers the activation energy of a reaction by 20.0 kJ mol^{-1} at 300 K, leaving the pre-exponential factor unchanged. By about what factor does the rate of the reaction increase? ($R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$; $e^8 \approx 3.0 \times 10^3$)
- (1) about 8
 - (2) about 2.2×10^2
 - (3) about 3.0×10^3
 - (4) about 2.0×10^4
11. The acid-catalysed hydrolysis of ethyl acetate in a large excess of water follows first-order kinetics. Which one of the following statements about it is correct?
- (1) It is a unimolecular elementary reaction.
 - (2) Its rate depends on the concentrations of both the ester and water, but the concentration of water stays practically constant.
 - (3) Its observed rate constant does not depend on the concentration of the acid.
 - (4) Its half-life increases as the initial concentration of the ester increases.

12. Which one of the following statements is NOT correct?

- (1) The molecularity of a reaction can be zero or a fraction.
- (2) The order of a reaction can be zero or a fraction.
- (3) Molecularity applies only to elementary reactions.
- (4) The overall rate of a complex reaction is controlled by its slowest step.

13. The gas-phase decomposition $A(g) \rightarrow B(g) + C(g)$ is first order. Starting with pure A at a pressure of 0.40 atm in a closed vessel at constant temperature, the total pressure is 0.60 atm after 10 min. The total pressure after 30 min is

- (1) 0.75 atm
- (2) 0.70 atm
- (3) 0.80 atm
- (4) 0.65 atm

14. A substance A decomposes by two parallel first-order reactions: $A \rightarrow B$ with $k_1 = 0.020 \text{ min}^{-1}$ and $A \rightarrow C$ with $k_2 = 0.010 \text{ min}^{-1}$. The half-life of A and the percentage of B in the products are

- (1) 34.7 min and 66.7%
- (2) 23.1 min and 66.7%
- (3) 23.1 min and 50%
- (4) 69.3 min and 33.3%

15. The reaction $2NO(g) + Br_2(g) \rightarrow 2NOBr(g)$ is believed to go by the mechanism

Step 1: $NO + Br_2 \rightleftharpoons NOBr_2$ (fast equilibrium)

Step 2: $NOBr_2 + NO \rightarrow 2NOBr$ (slow)

The rate law and the overall order predicted by this mechanism are

- (1) rate = $k[NO][Br_2]$; order 2
- (2) rate = $k[NOBr_2][NO]$; order 2
- (3) rate = $k[NO]^2[Br_2]$; order 3
- (4) rate = $k[NO]^2[Br_2]^2$; order 4

16. The gas-phase reaction $2A(g) + B(g) \rightarrow \text{products}$ has the rate law rate = $k[A]^2[B]$. If the volume of the vessel is suddenly reduced to one-third of its value at constant temperature, the rate becomes

- (1) 9 times
- (2) 3 times
- (3) $1/27$ times
- (4) 27 times

17. The rate constant of a reaction varies with temperature as $k = (2.0 \times 10^{13} \text{ s}^{-1}) e^{(-15000 \text{ K}/T)}$. The activation energy of the reaction, and the value that k approaches as the temperature becomes very high, are ($R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)

- (1) 15.0 kJ mol^{-1} and $2.0 \times 10^{13} \text{ s}^{-1}$
- (2) $124.7 \text{ kJ mol}^{-1}$ and zero
- (3) $124.7 \text{ kJ mol}^{-1}$ and $2.0 \times 10^{13} \text{ s}^{-1}$
- (4) 287 kJ mol^{-1} and $2.0 \times 10^{13} \text{ s}^{-1}$

- 18.** The reaction $A \rightarrow \text{products}$ is second order in A, with rate $= -d[A]/dt = k[A]^2$ and $k = 0.50 \text{ L mol}^{-1} \text{ min}^{-1}$. If $[A]_0 = 0.20 \text{ mol L}^{-1}$, the time taken for [A] to fall to 0.050 mol L^{-1} is
- (1) 6 min
 - (2) 15 min
 - (3) 60 min
 - (4) 30 min
- 19.** For a reaction whose rate is proportional to the square of the concentration of a single reactant, the ratio of the time taken for 75% completion to the time taken for 50% completion is
- (1) 3
 - (2) 2
 - (3) 1.5
 - (4) 4
- 20.** The activation energy of a reaction is $45.95 \text{ kJ mol}^{-1}$. According to the Boltzmann distribution, the fraction of molecules at 300 K having energy equal to or greater than the activation energy is about ($R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)
- (1) 1×10^{-4}
 - (2) 1×10^{-8}
 - (3) 1×10^{-18}
 - (4) 8×10^{-3}
- 21.** For an exothermic reaction with $\Delta H = -40 \text{ kJ mol}^{-1}$, the activation energy of the forward reaction is 60 kJ mol^{-1} . A catalyst lowers the activation energy of the forward reaction by 20 kJ mol^{-1} . The activation energy of the backward reaction in the presence of the catalyst is
- (1) 100 kJ mol^{-1}
 - (2) 80 kJ mol^{-1}
 - (3) 40 kJ mol^{-1}
 - (4) 120 kJ mol^{-1}
- 22.** For a reaction between A and B, doubling [A] at constant [B] increases the rate 2.83 times, while doubling [B] at constant [A] halves the rate. The overall order of the reaction is
- (1) 0.5
 - (2) 2.5
 - (3) 1.5
 - (4) -0.5
- 23.** The activation energy of a reaction is 23.0 kJ mol^{-1} and its rate constant at 300 K is $2.0 \times 10^{-3} \text{ s}^{-1}$. Its rate constant at 400 K is about ($R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)
- (1) $4.0 \times 10^{-3} \text{ s}^{-1}$
 - (2) $2.0 \times 10^{-4} \text{ s}^{-1}$
 - (3) $2.0 \times 10^{-1} \text{ s}^{-1}$
 - (4) $2.0 \times 10^{-2} \text{ s}^{-1}$

24. Which one of the following is correct for a zero-order reaction?

- (1) Its half-life is independent of the initial concentration.
- (2) The units of its rate constant are s^{-1} .
- (3) A plot of $[A]$ against t is a straight line of slope $-k$, and its half-life is proportional to $[A]_0$.
- (4) Its rate decreases steadily as the reaction proceeds.

25. The rate constant of a reaction is $0.025 \text{ mol L}^{-1} \text{ s}^{-1}$. The time taken for the concentration of the reactant to fall from 1.0 mol L^{-1} to 0.25 mol L^{-1} is

- (1) 55.5 s
- (2) 15 s
- (3) 60 s
- (4) 30 s

26. A first-order reaction has a half-life of 10 min. If the initial concentration of the reactant is 0.50 mol L^{-1} , the rate of the reaction after 20 min is ($\ln 2 = 0.693$)

- (1) $3.47 \times 10^{-2} \text{ mol L}^{-1} \text{ min}^{-1}$
- (2) $8.7 \times 10^{-3} \text{ mol L}^{-1} \text{ min}^{-1}$
- (3) $1.73 \times 10^{-2} \text{ mol L}^{-1} \text{ min}^{-1}$
- (4) $4.3 \times 10^{-3} \text{ mol L}^{-1} \text{ min}^{-1}$

27. The activation energy of a reaction is 50.0 kJ mol^{-1} . Its rate constant at 300 K becomes four times as large at a temperature of about ($R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$; $\ln 4 = 1.386$)

- (1) 311 K
- (2) 345 K
- (3) 322 K
- (4) 400 K

28. Which one of the following statements about the collision theory of reaction rates is correct?

- (1) Only collisions in which the molecules have at least a threshold energy and the proper orientation lead to reaction.
- (2) Every collision between reactant molecules leads to the formation of products.
- (3) The probability (steric) factor P is greater than 1 for reactions between complex molecules.
- (4) A rise in temperature increases the rate mainly by increasing the number of collisions per second.

29. For a first-order reaction, a plot of $\log_{10}[A]$ against time t is a straight line of slope $-2.0 \times 10^{-3} \text{ s}^{-1}$. The half-life of the reaction is about

- (1) 150 s
- (2) 347 s
- (3) 100 s
- (4) 301 s

30. The concentration of a reactant A was measured during a reaction at constant temperature:
t = 0 min: [A] = 0.80 M; t = 10 min: [A] = 0.40 M; t = 20 min: [A] = 0.267 M; t = 30 min: [A] = 0.20 M.
The order of the reaction and its rate constant are

- (1) first order, $k = 0.0693 \text{ min}^{-1}$
- (2) zero order, $k = 0.040 \text{ mol L}^{-1} \text{ min}^{-1}$
- (3) second order, $k = 0.125 \text{ L mol}^{-1} \text{ min}^{-1}$
- (4) second order, $k = 0.25 \text{ L mol}^{-1} \text{ min}^{-1}$

END OF THE QUESTION PAPER

ANSWER KEY

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
(3)	(1)	(4)	(2)	(2)	(4)	(1)	(3)	(4)	(3)
Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
(2)	(1)	(1)	(2)	(3)	(4)	(3)	(4)	(1)	(2)
Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30
(2)	(1)	(4)	(3)	(4)	(2)	(3)	(1)	(1)	(3)

WORKED SOLUTIONS

Q1. Answer (3). If the partial pressure of N_2O_4 falls by x , that of NO_2 rises by $2x$ and the total rises by x . So $x = 0.56 - 0.50 = 0.06 \text{ atm}$ in $30 \text{ s} = 0.5 \text{ min}$, and the average rate of disappearance of $\text{N}_2\text{O}_4 = 0.06/0.5 = 0.12 \text{ atm min}^{-1}$. $0.24 \text{ atm min}^{-1}$ is the rate of formation of NO_2 ; 2.0×10^{-3} is in atm s^{-1} .

Q2. Answer (1). The overall order is $n = \frac{1}{2} + 1 = 3/2$. Rate has units $\text{mol L}^{-1} \text{s}^{-1}$, so $k = \text{rate}/[\text{conc}]^n$ has units $(\text{mol L}^{-1})^{(1-n)} \text{s}^{-1} = (\text{mol L}^{-1})^{(-1/2)} \text{s}^{-1} = \text{mol}^{(-1/2)} \text{L}^{(1/2)} \text{s}^{-1}$. $\text{L mol}^{-1} \text{s}^{-1}$ is for a second-order reaction.

Q3. Answer (4). Experiments 1 and 2: doubling $[\text{A}]$ multiplies the rate by 4, so the order in A is 2. Experiments 2 and 3: multiplying $[\text{B}]$ by 4 doubles the rate, so the order in B is $\frac{1}{2}$. Compared with experiment 1, the new rate is $2.0 \times 10^{-3} \times 3^2 \times 9^{(1/2)} = 2.0 \times 10^{-3} \times 27 = 5.4 \times 10^{-2} \text{ M s}^{-1}$. Taking B as first order gives 1.6×10^{-1} .

Q4. Answer (2). For an n th-order reaction $t_{1/2} \propto [\text{A}]_0^{(1-n)}$. Here the concentration is multiplied by 4 and $t_{1/2}$ by $\frac{1}{4}$, so $1 - n = -1$ and $n = 2$. For a second-order reaction $t_{1/2} = 1/(k[\text{A}]_0)$, so $k = 1/(200 \times 0.10) = 5.0 \times 10^{-2} \text{ L mol}^{-1} \text{s}^{-1}$.

Q5. Answer (2). $[\text{A}] = 4[\text{B}]_0 \times 2^{-(t/10)}$ and $[\text{B}] = [\text{B}]_0 \times 2^{-(t/40)}$. Equal when $2^{(2-t/10)} = 2^{-(t/40)}$: $2 = t(1/10 - 1/40) = 3t/40$, so $t = 80/3 \approx 26.7 \text{ min}$. 20 min is two half-lives of A, ignoring that B decays too.

Q6. Answer (4). $0.80 \rightarrow 0.20$ is two half-lives, so $t_{1/2} = 20 \text{ min}$. $0.20 \rightarrow 0.10 \rightarrow 0.050 \rightarrow 0.025$ is three more half-lives: $3 \times 20 = 60 \text{ min}$.

Q7. Answer (1). Zero order: $[\text{A}] = [\text{A}]_0 - kt$, so $k = 0.30/15 = 0.020 \text{ mol L}^{-1} \text{min}^{-1}$. $t_{1/2} = [\text{A}]_0/2k = 0.60/0.040 = 15 \text{ min}$, and complete reaction from 0.80 mol L^{-1} takes $[\text{A}]_0/k = 40 \text{ min}$. 34.7 min is $\ln 2/k$, a first-order formula.

Q8. Answer (3). $\log(k_2/k_1) = (E_a/2.303R)(T_2 - T_1)/(T_1 T_2)$: $0.301 = (E_a/(2.303 \times 8.314)) \times 10/(300 \times 310)$. $E_a = 0.301 \times 2.303 \times 8.314 \times 9300 \approx 53.6 \text{ kJ mol}^{-1}$.

Q9. Answer (4). $\log k = \log A - E_a/(2.303RT)$, so the slope is $-E_a/2.303R$. $E_a = 2.303 \times 8.314 \times 2500 \approx 47.9 \text{ kJ mol}^{-1}$. 20.8 kJ mol^{-1} forgets the factor 2.303, which belongs to a plot of $\log_{10} k$ (not $\ln k$).

Q10. Answer (3). $k_{\text{cat}}/k = e^{(\Delta E_a/RT)} = e^{(20000/(8.314 \times 300))} = e^{(8.02)} \approx 3.0 \times 10^3$. 'About 8' stops at the exponent.

Q11. Answer (2). $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH}$: the rate is $k[\text{ester}][\text{H}_2\text{O}]$, but water is in such excess that $[\text{H}_2\text{O}]$ hardly changes, so the reaction behaves as first order (pseudo first order) with $k' = k[\text{H}_2\text{O}]$. It is not unimolecular; the observed constant depends on $[\text{H}^+]$, the catalyst; and a first-order half-life does not depend on the initial concentration.

Q12. Answer (1). Molecularity is the number of species colliding in an elementary step, so it is a whole number (1, 2 or, rarely, 3) and never zero or fractional. Order is found by experiment and can be zero or fractional. Molecularity has no meaning for a complex reaction, whose rate is decided by its slowest (rate-determining) step.

Q13. Answer (1). If A's pressure falls by x , the total is $0.40 + x$, so $p_A = 0.40 - x = 2(0.40) - P_{\text{total}}$. After 10 min $p_A = 0.80 - 0.60 = 0.20 \text{ atm}$: one half-life is 10 min. After 30 min (three half-lives) $p_A = 0.40/8 = 0.05 \text{ atm}$, so $P_{\text{total}} = 0.80 - 0.05 = 0.75$

atm.

Q14. Answer (2). A disappears with $k = k_1 + k_2 = 0.030 \text{ min}^{-1}$, so $t_{1/2} = 0.693/0.030 = 23.1 \text{ min}$. At every instant B and C form in the ratio $k_1 : k_2 = 2 : 1$, so B is $2/3 = 66.7\%$ of the products. 34.7 min uses k_1 alone.

Q15. Answer (3). The slow step gives rate $= k_2[\text{NOBr}_2][\text{NO}]$. NOBr_2 is an intermediate; from the fast equilibrium $[\text{NOBr}_2] = K[\text{NO}][\text{Br}_2]$. So rate $= k_2K[\text{NO}]^2[\text{Br}_2] = k[\text{NO}]^2[\text{Br}_2]$, third order overall. A rate law must not contain the intermediate's concentration.

Q16. Answer (4). Reducing the volume to one-third triples every concentration. The rate is multiplied by $3^2 \times 3 = 27$.

Q17. Answer (3). Comparing with $k = A e^{(-E_a/RT)}$: $E_a/R = 15000 \text{ K}$, so $E_a = 15000 \times 8.314 = 124.7 \text{ kJ mol}^{-1}$. As $T \rightarrow \infty$ the exponent tends to 0 and $k \rightarrow A = 2.0 \times 10^{13} \text{ s}^{-1}$ (every collision has enough energy). 287 kJ mol^{-1} wrongly multiplies by 2.303 as well.

Q18. Answer (4). $1/[A] - 1/[A]_0 = kt$: $1/0.050 - 1/0.20 = 20 - 5 = 15 \text{ L mol}^{-1}$, so $t = 15/0.50 = 30 \text{ min}$.

Q19. Answer (1). For a second-order reaction $t = (1/k)(1/[A] - 1/[A]_0)$. 50%: $(1/k)(2 - 1)/[A]_0$; 75%: $(1/k)(4 - 1)/[A]_0$. The ratio is 3. (It is 2 for a first-order reaction and 1.5 for a zero-order one.)

Q20. Answer (2). Fraction $= e^{(-E_a/RT)}$. $\log(\text{fraction}) = -E_a/(2.303RT) = -45950/(2.303 \times 8.314 \times 300) = -8.0$, so the fraction is about 1×10^{-8} .

Q21. Answer (2). $\Delta H = E_a(\text{forward}) - E_a(\text{backward})$, so without the catalyst $E_a(\text{backward}) = 60 + 40 = 100 \text{ kJ mol}^{-1}$. A catalyst lowers the energy barrier for both directions by the same amount and does not change ΔH , so with it $E_a(\text{backward}) = 100 - 20 = 80 \text{ kJ mol}^{-1}$ (forward 40 kJ mol^{-1}).

Q22. Answer (1). $2^x = 2.83 = 2^{1.5}$ gives order 1.5 in A; $2^y = 1/2$ gives order -1 in B. Overall order $= 1.5 - 1 = 0.5$. 2.5 adds the magnitudes.

Q23. Answer (4). $\log(k_2/k_1) = (E_a/2.303R)(1/T_1 - 1/T_2) = (23000/(2.303 \times 8.314)) \times (1/300 - 1/400) = 1201 \times (1/1200) \approx 1.0$. So $k_2 = 10k_1 = 2.0 \times 10^{-2} \text{ s}^{-1}$.

Q24. Answer (3). Zero order: rate $= k$, constant until the reactant runs out (so the rate does not fall); $[A] = [A]_0 - kt$ is a straight line of slope $-k$; $t_{1/2} = [A]_0/2k$ is proportional to $[A]_0$; and k has the units of rate, $\text{mol L}^{-1} \text{ s}^{-1}$. An initial-concentration-independent half-life and units of s^{-1} belong to first order.

Q25. Answer (4). The units $\text{mol L}^{-1} \text{ s}^{-1}$ show that the reaction is zero order, so $[A]_0 - [A] = kt$: $t = (1.0 - 0.25)/0.025 = 30 \text{ s}$. 55.5 s wrongly uses the first-order equation, $t = (2.303/k) \log 4$.

Q26. Answer (2). $k = 0.693/10 = 0.0693 \text{ min}^{-1}$. After 20 min (two half-lives), $[A] = 0.50/4 = 0.125 \text{ mol L}^{-1}$. Rate $= k[A] = 0.0693 \times 0.125 = 8.7 \times 10^{-3} \text{ mol L}^{-1} \text{ min}^{-1}$. 3.47×10^{-2} is the initial rate.

Q27. Answer (3). $\ln 4 = (E_a/R)(1/300 - 1/T)$: $1/T = 1/300 - 1.386 \times 8.314/50000 = 0.003333 - 0.000230 = 0.003103$, so $T \approx 322 \text{ K}$.

Q28. Answer (1). Effective collisions need enough energy (at least the threshold) and the proper orientation; most collisions are not effective. $P \leq 1$ and is small for complex molecules. A rise in temperature increases the rate mainly by increasing the fraction of molecules with energy at least E_a ($e^{(-E_a/RT)}$); the collision frequency rises only slowly, as $\sqrt{T}$.

Q29. Answer (1). $\log[A] = \log[A]_0 - kt/2.303$, so $k = 2.303 \times 2.0 \times 10^{-3} = 4.61 \times 10^{-3} \text{ s}^{-1}$ and $t_{1/2} = 0.693/k \approx 150 \text{ s}$. 347 s takes the slope itself as k .

Q30. Answer (3). $1/[A] = 1.25, 2.5, 3.75$ and 5.0 L mol^{-1} : it rises by the same 1.25 L mol^{-1} in each 10 min, so $1/[A]$ is linear in t and the reaction is second order with $k = 1.25/10 = 0.125 \text{ L mol}^{-1} \text{ min}^{-1}$. It is not first order: the second half-life (from 0.40 M, 20 min to reach 0.20 M) is twice the first (10 min).

All questions are original and © Master Testing Agency. Free to download and use for personal practice; not for resale. Every answer in this paper was checked independently by computer: rate equations integrated step by step, orders found from the data by logarithms, Arrhenius results from the equation itself, and each statement question against a table of which statements are true.