	INDIAN SCHOOL AL WADI AL KABIR	
Class: XII	**DEPARTMENT OF SCIENCE: 2026–2027** **SUBJECT: CHEMISTRY**	**Date: 01/11/2026**
Worksheet: 8	**CHAPTER: CHEMICAL KINETICS**	**Note:** **A4 FILE FORMAT**
CLASS & SEC:	**NAME OF THE STUDENT:**	**ROLL NO.**

I. MULTIPLE CHOICE QUESTIONS (1M)

1. For the reaction A + 2B → C, the rate law is given by Rate = k[A][B]^2. If the concentration of B is doubled, keeping [A] constant, the rate of reaction will:

   (a) Increase by 2 times
   (b) Increase by 4 times
   (c) Increase by 8 times
   (d) Remain unchanged

2. In the Arrhenius equation, when log k is plotted against 1/T, a straight line is obtained whose slope and intercept are respectively:

   (a) $-E_a/R$ and log A
   (b) $-E_a/(2.303\ R)$ and log A
   (c) $E_a/(2.303\ R)$ and A
   (d) $-E_a/RT$ and ln A

3. For a zero-order reaction R → P, the half-life period ($t_{1/2}$) depends on the initial concentration $[R]_0$ as:

   (a) $t_{1/2}$ is directly proportional to $[R]_0$
   (b) $t_{1/2}$ is inversely proportional to $[R]_0$
   (c) $t_{1/2}$ is proportional to $[R]_0^2$
   (d) $t_{1/2}$ is independent of $[R]_0$

4. Which of the following statements about the molecularity of a reaction is CORRECT?

   (a) Molecularity can be zero or a fraction.
   (b) Molecularity is determined experimentally for complex reactions.
   (c) Molecularity is the number of reacting species colliding simultaneously in an elementary step.
   (d) Molecularity changes with temperature and pressure.

5. What is the unit of rate constant (k) for a second-order reaction?

   (a) mol L^{-1} s^{-1}
   (b) s^{-1}
   (c) L mol^{-1} s^{-1}
   (d) L^2 mol^{-2} s^{-1}

6. Given below is the decomposition of hydrogen peroxide, $2H_2O_2 \rightarrow 2H_2O + O_2$, catalysed by I^- ions in alkaline medium. It takes place in two steps:

   Step I: $H_2O_2 + I^- \rightarrow H_2O + IO^-$ (slow)
   Step II: $H_2O_2 + IO^- \rightarrow H_2O + I^- + O_2$ (fast)

   The molecularity of Step I is:

(a) 1 (b) 2

(c) 3 (d) 0

7. Hydrolysis of sucrose in excess water ($C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$) is an example of:

(a) Zero-order reaction (b) First-order reaction

(c) Pseudo-first-order reaction (d) Second-order reaction

8. The role of a catalyst in a chemical reaction is to change:

(a) Equilibrium constant (K_{eq}) (b) Enthalpy of reaction (Δ_rH)

(c) Activation energy (E_a) (d) Gibbs free energy change (Δ_rG)

9. In the Arrhenius equation $k = Ae^{-Ea/RT}$, the exponential factor $e^{-Ea/RT}$ represents:

(a) Total collision frequency Z_{AB} (b) Steric factor P

(c) Fraction of molecules having kinetic energy equal to or greater than E_a (d) Rate of disappearance of reactants

10. For a first-order gas phase decomposition $A(g) \rightarrow B(g) + C(g)$, if initial pressure is p_i and total pressure at time t is p_t, the rate constant expression is:

(a) $k = (2.303/t) \log (p_i/p_t)$ (b) $k = (2.303/t) \log [p_i/(2p_i - p_t)]$

(c) $k = (2.303/t) \log [2p_i/(p_i - p_t)]$ (d) $k = (2.303/t) \log (p_t/p_i)$

II. ASSERTION REASON TYPE (1M)

In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:

(a) Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.

(b) Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.

(c) Assertion is correct, but reason is a wrong statement.

(d) Assertion is wrong, but reason is a correct statement.

11. **Assertion (A):** Order of reaction and molecularity are always the same for complex reactions.
Reason (R): Order is determined experimentally, whereas molecularity is applicable only to elementary steps.

12. **Assertion (A):** The units of rate constant of a zero-order reaction and rate of reaction are identical.
Reason (R): In a zero-order reaction, the rate of reaction is independent of reactant concentration.

13. **Assertion (A):** The enthalpy of reaction (Δ_rH) remains constant in the presence of a catalyst.
Reason (R): A catalyst lowers activation energy of both forward and reverse reactions by equal amounts, keeping the difference in energy between reactants and products unchanged.

14. **Assertion (A):** All molecular collisions between reactant molecules result in product formation.
    Reason (R): Only collisions where molecules possess threshold energy and proper steric orientation are effective collisions.

III. SHORT ANSWER TYPE I (2M)

15. Define molecularity of a reaction. State any one condition under which a bimolecular reaction can kinetically obey first-order kinetics.

16. A first-order reaction has a rate constant $k = 1.25 \times 10^{-3}\ s^{-1}$. How long will 5 g of this reactant take to reduce to 2.5 g? (Given: log 2 = 0.3010)

17. Write any two main differences between order of a reaction and molecularity of a reaction.

18. Identify the order of reaction if the units of its rate constant are:
    (a) $L\ mol^{-1}\ s^{-1}$
    (b) s^{-1}

IV. SHORT ANSWER TYPE II (3M)

20. For the gaseous phase chemical reaction carried out in a closed vessel:
    $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$
    the concentration of NO_2 increases by 20×10^{-3} mol L^{-1} in 5 seconds. Calculate:
    (a) The rate of formation of NO_2
    (b) The rate of reaction
    (c) The rate of consumption of N_2O_5

21. The rate of a reaction doubles when the temperature changes from 27°C (300 K) to 37°C (310 K). Calculate the activation energy (E_a) of the reaction.
    (Given: $R = 8.314\ J\ K^{-1}\ mol^{-1}$, log 2 = 0.3010)

22. The following data were obtained during the first-order thermal decomposition of C_2H_5Cl at constant volume:
    $C_2H_5Cl(g) \rightarrow C_2H_4(g) + HCl(g)$

Experiment	Time (s)	Total pressure (atm)
1	0	0.4
2	100	0.6

    Calculate the rate constant (k) for the reaction. (Given: log 2 = 0.3010)

23. A first-order reaction is 50% complete in 40 minutes. Calculate the time required for 90% completion of the reaction.
    (Given: log 2 = 0.3010, log 10 = 1)

24. Hydrolysis of sucrose takes place according to the chemical reaction:
    $C_{12}H_{22}O_{11} + H_2O\ (excess) \rightarrow^{H^+} C_6H_{12}O_6 + C_6H_{12}O_6$
    Based on the above reaction, write:
    (a) The rate law expression for this reaction.
    (b) Its molecularity and order of reaction.
    (c) What special name is given to such chemical reactions?

V. LONG ANSWER TYPE (5M)

25. (a) What do you understand by rate law and rate constant of a chemical reaction?
    (b) Write the differential rate law expression for a reaction $2A + B \rightarrow C$ which is first-order in A and second-order in B.
    (c) How is the rate of reaction affected if:
        (i) the concentration of B alone is tripled?
        (ii) concentrations of both A and B are doubled?
    (d) Write the rate expression for the zero-order reaction $2HI \rightarrow H_2 + I_2$ and state the unit of its rate constant.

26. (a) Derive the integrated rate equation for a first-order chemical reaction $R \rightarrow P$.
    (b) For a first-order reaction, prove that the time required for 99% completion is twice the time required for 90% completion.
    (c) State the effect of adding a positive catalyst on (i) activation energy (E_a), and (ii) enthalpy of reaction ($\Delta_r H$).

27. (a) Explain the collision theory of chemical reaction rates. Define activation energy.
    (b) Write the modified Arrhenius equation incorporating the steric/orientation factor (P) and collision frequency (Z_{AB}).
    (c) Write the rate equation for the reaction $2A + B \rightarrow C$ if the order of the reaction is zero.
    (d) In a reaction, if the concentration of reactant A is tripled, the rate of reaction becomes twenty-seven times. What is the order of the reaction?

VI. CASE BASED QUESTIONS (4M)

28. **CASE STUDY 1: Temperature Dependence and Industrial Catalysis**
    Chemical kinetics provides critical insights into reaction speeds and mechanisms. In industrial chemical synthesis, maximizing reaction rate while minimizing energy costs is essential. According to Arrhenius theory, the rate constant k depends exponentially on temperature: $k = Ae^{-Ea/RT}$. A temperature rise increases the fraction of molecules with kinetic energy equal to or greater than the activation energy E_a. Alternatively, introducing a catalyst lowers E_a by providing an alternate reaction pathway with a lower-energy activated complex.
    Answer the following questions:
    (a) Why does a 10°C rise in temperature nearly double the rate constant of a reaction?
    (b) What does the exponential term $e^{-Ea/RT}$ represent in the Arrhenius equation?
    (c) Explain why a catalyst increases reaction rate without affecting the equilibrium constant (K_{eq}) or enthalpy change ($\Delta_r H$) of the reaction.

29. **CASE STUDY 2: Experimental Determination of Rate Laws**
    The rate law for a chemical reaction cannot be predicted merely from the stoichiometric coefficients of a balanced equation; it must be determined experimentally. In a laboratory study

of the gaseous reaction $A_{(g)} + B_{(g)} \rightarrow C_{(g)} + D_{(g)}$ at 298 K, the following initial rate data were recorded:

Exp.	Initial $[A_{(g)}]$ / mol dm^{-3}	Initial $[B_{(g)}]$ / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
I	3.0×10^{-2}	2.0×10^{-2}	1.89×10^{-4}
II	3.0×10^{-2}	4.0×10^{-2}	1.89×10^{-4}
III	6.0×10^{-2}	4.0×10^{-2}	7.56×10^{-4}

Answer the following questions:

(a) Determine the order of reaction with respect to $A_{(g)}$ and $B_{(g)}$.

(b) Write the differential rate law equation for the reaction.

(c) Calculate the value of rate constant k with appropriate units.

Answer Key

Q. No.	Answer
I.	**MULTIPLE CHOICE QUESTIONS (1M)**
1	(b) Increase by 4 times.
2	(b) $-E_a/(2.303\ R)$ and log A.
3	(a) $t_{1/2}$ is directly proportional to $[R]_0$.
4	(c) Molecularity is the number of reacting species colliding simultaneously in an elementary step.
5	(c) L mol^{-1} s^{-1}.
6	(b) 2.
7	(c) Pseudo-first-order reaction.
8	(c) Activation energy (E_a).
9	(c) Fraction of molecules having kinetic energy equal to or greater than E_a.
10	(b) $k = (2.303/t) \log [p_i/(2p_i - p_t)]$.
II.	**ASSERTION REASON TYPE (1M)**
11	(d) Assertion is wrong, but reason is a correct statement.
12	(a) Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
13	(a) Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
14	(d) Assertion is wrong, but reason is a correct statement.
III.	**SHORT ANSWER TYPE I (2M)**
15	Molecularity: The total number of reacting species (atoms, ions or molecules) taking part in an elementary step, which must collide simultaneously to bring about a chemical reaction. Condition for first-order kinetics: When one of the reactants is present in large excess (e.g. hydrolysis of an ester or sucrose in water), the reaction becomes pseudo-first order.

Q. No.	Answer
16	$k = (2.303/t) \log ([R]_0/[R])$ Given: $k = 1.25 \times 10^{-3}\ s^{-1}$, $[R]_0 = 5$ g, $[R] = 2.5$ g $t = (2.303/1.25 \times 10^{-3}) \log (5/2.5) = 1842.4 \times \log 2$ $t = 1842.4 \times 0.3010 = 554.6$ s
17	1) Order is the sum of the powers of the concentration terms in the experimental rate law; molecularity is the number of species colliding in an elementary step. 2) Order can be zero, fractional or an integer and applies to the overall reaction; molecularity is always a positive integer (1, 2, 3) and applies only to elementary steps.
18	(a) L mol^{-1} s^{-1} → Second-order reaction (b) s^{-1} → First-order reaction
IV.	**<u>SHORT ANSWER TYPE II (3M)</u>**
20	$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$ (a) Rate of formation of $NO_2 = \Delta[NO_2]/\Delta t = (20 \times 10^{-3}\ mol\ L^{-1})/5\ s = 4 \times 10^{-3}\ mol\ L^{-1}\ s^{-1}$ (b) Rate of reaction = ¼ × $\Delta[NO_2]/\Delta t = ¼ \times 4 \times 10^{-3} = 1 \times 10^{-3}\ mol\ L^{-1}\ s^{-1}$ (c) Rate of consumption of $N_2O_5 = -\Delta[N_2O_5]/\Delta t = 2 \times$ rate of reaction $= 2 \times 10^{-3}\ mol\ L^{-1}\ s^{-1}$
21	$\log (k_2/k_1) = [E_a/(2.303\ R)] \times [(T_2 - T_1)/(T_1T_2)]$ Given: $k_2/k_1 = 2$, $T_1 = 300$ K, $T_2 = 310$ K, $R = 8.314\ J\ K^{-1}\ mol^{-1}$ $\log 2 = [E_a/(2.303 \times 8.314)] \times [(310 - 300)/(300 \times 310)]$ $0.3010 = (E_a/19.147) \times (10/93000)$ $E_a = (0.3010 \times 19.147 \times 93000)/10 = 53{,}598.6\ J\ mol^{-1} = 53.6\ kJ\ mol^{-1}$
22	$C_2H_5Cl(g) \rightarrow C_2H_4(g) + HCl(g)$ At t = 0: $p_i = 0.4$ atm At t = 100 s: $p_{total} = p_i + x = 0.4 + x = 0.6 \Rightarrow x = 0.2$ atm Partial pressure of $C_2H_5Cl = p_i - x = 0.4 - 0.2 = 0.2$ atm $k = (2.303/t) \log (p_i/2pi\ -pt) = (2.303/100) \log (0.4/0.2) = 0.02303 \times 0.3010 = 6.93 \times 10^{-3}\ s^{-1}$
23	$k = 0.693/t_{1/2} = 0.693/40\ min = 0.017325\ min^{-1}$ For 90% completion: $[R] = [R]_0 - 0.90[R]_0 = 0.10[R]_0$ $t_{90\%} = (2.303/k) \log ([R]_0/0.10[R]_0) = (2.303/0.017325) \times \log 10$ $t_{90\%} = 132.9$ min
24	(a) Rate = $k[C_{12}H_{22}O_{11}]^1[H_2O]^0$ or Rate = $k[C_{12}H_{22}O_{11}]$ (b) Molecularity = 2 (bimolecular); Order = 1 (first order) (c) Pseudo-unimolecular or pseudo-first-order reaction
V.	**<u>LONG ANSWER TYPE (5M)</u>**

Q. No.	Answer
25	(a) Rate law: the mathematical expression relating the rate of reaction to the molar concentrations of reactants, each raised to an experimentally determined power. Rate constant (k): the proportionality constant in the rate law; it equals the rate when the concentration of each reactant is unity. (b) Rate = $-d[R]/dt = k[A]^1[B]^2$ (1M) (c) (i) If [B] is tripled, Rate′ = $k[A](3[B])^2 = 9 \times$ Rate (increases 9 times). (ii) If [A] and [B] are both doubled, Rate″ = $k(2[A])(2[B])^2 = 8 \times$ Rate (increases 8 times). (d) Rate = $k[HI]^0 = k$. Unit of k: mol L^{-1} s^{-1}
26	(a) For R → P: $-d[R]/dt = k[R] \Rightarrow d[R]/[R] = -k\,dt$. Integrating: $\ln[R] = -kt + C$. At t = 0, $[R] = [R]_0 \Rightarrow C = \ln[R]_0$. Thus $\ln([R]_0/[R]) = kt \Rightarrow k = (2.303/t) \log([R]_0/[R])$. (b) $t_{90\%} = (2.303/k) \log(100/10) = 2.303/k$ $t_{99\%} = (2.303/k) \log(100/1) = 2 \times (2.303/k) = 2 \times t_{90\%}$ (c) (i) A catalyst lowers the activation energy (E_a). (ii) The enthalpy change ($\Delta_r H$) remains unchanged.
27	(a) Collision theory: chemical reactions occur as a result of collisions between reactant molecules. **Activation energy** is the minimum extra amount of energy that reactant molecules must acquire to undergo a chemical reaction and form products. (b) $k = PZ_{AB}e^{-Ea/RT}$, where P is the steric/orientation factor and Z_{AB} is the collision frequency. (c) Rate = $k\,[A]^0\,[B]^0 = k$ (d) For the reaction, rate (r) = $k\,[A]^n$ ……..(1) According to the given date rate (27r) = $k\,[3A]^n$ ……(2) Dividing equation (2) by (1) , $(27r)/(r) = k\,[3A]^n / k\,[A]^n \Rightarrow 27 = 3n \Rightarrow n = 3$ The order of the reaction is 3.
VI.	**<u>CASE BASED QUESTIONS (4M)</u>**
28	(a) A 10°C rise in temperature roughly doubles the fraction of molecules with energy ≥ E_a , so the number of effective collisions nearly doubles. (b) $e^{-Ea/RT}$ represents the fraction of molecules having energy equal to or greater than the activation energy E_a. (c) A catalyst lowers the activation energies of the forward and backward reactions by equal amounts, speeding up both equally; hence K_{eq} and $\Delta_r H$ remain unchanged. (2M)
29	(a) Exp. I and II: ⇒ order with respect to B = 0. Exp. II and III: order with respect to A = 2. (b) Rate = $k[A]^2[B]^0 = k[A]^2$ (c) Using Exp. I: 1.89×10^{-4} mol dm^{-3} $s^{-1} = k\,(3.0 \times 10^{-2}$ mol $dm^{-3})^2$ $k = (1.89 \times 10^{-4})/(9.0 \times 10^{-4}) = 0.21$ or L mol^{-1} s^{-1}

Prepared by:	*Checked by:*
Ms Jenesha Joseph	*HOD Science*