JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- CHEMISTRY
CLASS :- 12th   **PAPER CODE :- CWT-3**
CHAPTER :- CHEMICAL KINETICS

ANSWER KEY

1.	(A)	2.	(D)	3.	(D)	4.	(A)	5.	(A)	6.	(C)	7.	(C)
8.	(A)	9.	(B)	10.	(D)	11.	(C)	12.	(C)	13.	(C)	14.	(B)
15.	(C)	16.	(C)	17.	(A)	18.	(C)	19.	(C)	20.	(B)	21.	2
22.	2	23.	96	24.	3	25.	3	26.	30	27.	10	28.	16
29.	4.0	30.	32										

SOLUTIONS

1. (A)
**Sol.** $K = (mol\ L^{-1})^{1-n}\ sec^{-1}$, n = 0, 1.
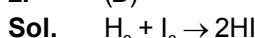
2. (D)
Sol. $H_2 + I_2 \rightarrow 2HI$
When 1 mole of H_2 and 1 mole of I_2 reacts, 2 moles of HI are formed in the same time interval. Thus the rate may be expressed as

$$\frac{-\Delta[H_2]}{\Delta t} = \frac{-\Delta[I_2]}{\Delta t} = \frac{1}{2}\frac{\Delta[HI]}{\Delta t}$$

The negative sign signifies a decrease in concentration of the reactant with increase of time.

$$H_2 + I_2 \rightarrow 2HI$$
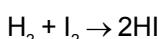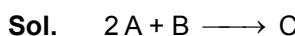
3. (D)
Sol. $2A + B \longrightarrow C$ rate = k [A] [B]

The value of k (velocity constant) is always independent of the concentration of reactant and it is a function of temperature only.

4. (A)
Sol. Generally, molecularity of simple reactions is equal to the sum of the number of molecules of reactants involved in the balanced stoichiometric equation. Thus, a reaction involving two different reactants can never be unimolecular.

5. (A)
Sol. Pressure will be doubled only when the reaction is 100% complete.
100 % completion occurs is zero order among all above option.]

6. (C)
Sol. $-\dfrac{1}{2}\dfrac{dNO_2^-}{dt} = \dfrac{1}{4}\dfrac{d[H^+]}{dt} = \dfrac{1}{2}\dfrac{dNO}{dt} = k[NO_2^-][H^+][I^-]$

$\Rightarrow \dfrac{dNO_2}{dt} = 2k_0 X = k_1 [X]$

$\dfrac{d[H^+]}{dt} = 4k_0 X = k_2 X$

$\dfrac{dNO}{dt} = 2k_0 X = k_3 [X]$

$K_0 = \dfrac{k_1}{2} = \dfrac{k_2}{4} = \dfrac{k_3}{2}$

$k_1 = \dfrac{k_2}{2} = k_3]$

7. (C)
Sol. Given rate = k $[CO]^2$
Thus, according to the rate law expression doubling the concentration of CO increases the rate by a factor of 4.

8. (A)
Sol. At Steady State
$K_1[A] = K_2[B]$ and $K_3[C] = K_2[B]$
∴ $K_1[A] = K_3[C]$

$\dfrac{[A]}{[C]} = \dfrac{K_3}{K_1} = 40000$]

9. (B)
Sol. $k_{1(300K)} = \dfrac{0.693}{20}$; $k_{2(320)} = \dfrac{0.693}{5}$; $ln\dfrac{k_{2(320)}}{k_{1(300)}}$

$= \dfrac{E_a}{R}\left[\dfrac{1}{T_1} - \dfrac{1}{T_2}\right]$

$E_a = \dfrac{2.303R\,T_1 T_2}{(T_2 - T_1)}\log\dfrac{k_2}{k_1} = \dfrac{2.303 \times 8.314}{20 \times 1000} \times$

$300 \times 320 \log 4 \Rightarrow 55.14$ kJ/mol]

10. (D)
Sol. $\dfrac{0.693}{6.93} \times t = 2.303 \log \dfrac{[A]_0}{0.1[A]_0} \Rightarrow t = 23.03$ min]

11. (C)

Sol. $e^{-\frac{E_a}{RT}} \times 100 = 3.8 \times 10^{-16}$; $e^{-\frac{E_a}{RT}} = 3.8 \times 10^{-18}$

$-\frac{E_a}{RT} = \ln(3.8 \times 10^{-18})$; R = 8.314 & T = 300 ; E_a = 100 kJ / mole]

12. (C)

Sol. $A_1 e^{-Ea_1/RT} = A_2 e^{-Ea_2/RT}$

$\dfrac{A_2}{A_1} = e^{(Ea_2 - Ea_1)/RT}$

$10^2 = Exp\left\{\dfrac{600}{RT}\right\}$ R = 2 cal/K-mol

$2 \ln 10 = \dfrac{600}{2T}$

$T = \left\{\dfrac{300}{2 \times 2.303}\right\} K$]

13. (C)

Sol. Slope = $\dfrac{-k}{2.303}$

$\dfrac{-2}{10 \times 60} = \dfrac{-k}{2.303}$ $\Rightarrow$ k = 7.67 × 10^{-3} sec^{-1}
]

14. (B)

Sol. Rate = k . [Acetone]^x . [Br$_2$]^y . [H]^z
6 × 10^{-4} = k . (0.15)^x (0.025)^y (0.025)^z ... (i)
6 × 10^{-4} = k . (0.15)^x (0.050)^y (0.025)^z ... (ii)
12 × 10^{-4} = k . (0.15)^x (0.025)^y (0.050)^z . . . (iii)
8 × 10^{-4} = k . (0.20)^x (0.025)^y (0.025)^z ... (iv)

(i) ÷ (ii), $1 = \left(\dfrac{0.025}{0.050}\right)^y$

y = 0, hence rate does not depend upon the concentration of Br$_2$.

(i) ÷ (iii), $\dfrac{6}{12} = \left(\dfrac{0.025}{0.050}\right)^z$; $\dfrac{1}{2} = \left(\dfrac{1}{2}\right)^z$

∴   z = 1

(i) ÷ (iv), $\dfrac{3}{4} = \left(\dfrac{3}{4}\right)^x$

∴   x = 1   ]

15. (C)

Sol. Zero order reaction t$_{1/2}$ ∝ a & rate of reaction $-\dfrac{d[A]}{dt}$ is not depend on concentration of reactant]

16. (C)

Sol. $k = \dfrac{1}{t} . \ln\dfrac{C_0}{C} \Rightarrow \dfrac{0.693}{t_{1/2}} = \dfrac{1}{20} . \ln\dfrac{1}{0.8}$
t$_{1/2}$ = 62.13 min. Ans.   ]

17. (A)

Sol. For second order

$t_{1/2} = \dfrac{1}{[A]_0 k}$

log t$_{1/2}$ = –log [A]$_0$ + log 1/k
Hence reaction is second order.

$k = \dfrac{1}{t}\left[\dfrac{1}{[A]_t} - \dfrac{1}{[A]_0}\right]$

$\dfrac{4}{A_0} - \dfrac{1}{A_0} = k\, t_{75\%}$

$\dfrac{4}{3[A]_0} - \dfrac{1}{[A]_0} = kt_{25\%}$

$t_{25\%} = \dfrac{300}{9} = 33.33$ min.   ]

18. (C)
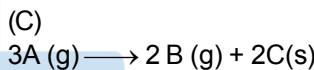
Sol. 3A (g) $\longrightarrow$ 2 B (g) + 2C(s)
t = 0   6 atm   0
t = 20 min   (6 – 3x) atm   2x atm
t = ∞   0   4 atm
But at t = ∞, the total pressure is 4.05 atm.
The addition pressure is due to V.P. of solid, which is (4.05 – 4) $\Rightarrow$ 0.05 atm
P$_T$ = P$_A$ + P$_B$ + V.P. of solid
or , 5.05 = (6 –3x) + 2x + 0.05 $\Rightarrow$ x = 1
∴ t$_{1/2}$ = 20 min $\Rightarrow$ t$_{75\%}$ = 40 min, t$_{87.5\%}$ = 60 min
t$_{93.75\%}$ = 80 min **Ans**

19. (C)

Sol. k = Ae$^{-Ea/RT}$
$= 4096 \times e^{\frac{-3100 R \ln 2}{R \times 310}}$

$= 4096 \times \dfrac{1}{20^{10}} = 4$ hr^{-1}

$t_{1/2} = \dfrac{\ln}{k} = \dfrac{0.7}{4} \times 60 = 10.5$ min. **Ans.**]

20. (B)

Sol. The correct explanation of statement (1) is law of stoichiometry]

21. 2

Sol. $NO(g) + Br_2(g) \rightleftharpoons NOBr_2(g)$

$NOBr_2(g) + NO(g) \longrightarrow 2NOBr(g)$ [rate determining step]
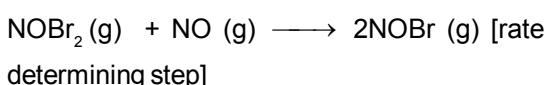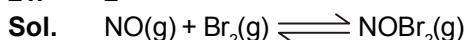
Rate of the reaction $(r) = k[NOBr_2][NO]$

where $[NOBr_2] = K_c[NO][Br_2]$

$r = k \cdot K_c \cdot [NO][Br_2][NO]$

$r = k'[NO]^2[Br_2]$.

The order of the reaction with respect to $NO(g)$ = 2.

22. 2

Sol. $A(g) \rightarrow B(g) + C(g) + D(s)$

$\begin{array}{ccc} 1-\alpha & \alpha & \alpha \end{array} \qquad n_T = 1 + \alpha$

$\dfrac{1+\alpha}{1} = 1.75 \qquad \Rightarrow \alpha = 0.75$

$K \times t = \ln 4 \Rightarrow t = 2$]

23. 96

Sol. $E_{net} = \dfrac{k_1(E_{a_1})}{k_1 + k_2} + \dfrac{k_2(E_{a_2})}{k_1 + k_2}$

$= \dfrac{10^{-2} \times 80 + 4 \times 10^{-2} \times 100}{10^{-2} + 4 \times 10^{-2}} = \dfrac{0.8 + 4}{5 \times 10^{-2}} = 96$ kJ/mole   ]

24. 3

Sol. $\dfrac{0.02 \times \dfrac{0.01}{100}}{10^{-3}} = K \, 0.02^n$

$\dfrac{0.04 \times \dfrac{0.01}{100}}{0.25 \times 10^{-3}} = K \, 0.04^n$

$2^n = 8$

$n = 3$]

25. 3

Sol. $t_{1/2} \propto C_{AO}^{1-n} \Rightarrow \dfrac{120}{30} = \left(\dfrac{0.1}{0.2}\right)^{1-n}$

or, $\dfrac{1}{4} = \left(\dfrac{1}{2}\right)^{n-1} \Rightarrow n - 1 = 2 \Rightarrow n = 3$]

26. 30

Sol. $K = A\,e^{-E_a/RT}$

$K = \dfrac{K_1 K_3}{K_2} \Rightarrow E_a = E_{a_1} + E_{a_3} - E_{a_2}$

$= (40 + 20 - 30)$ kJ $= 30$ kJ]

27. 10

Sol. $t_{1/2} = \dfrac{\ln 2}{k_{avg.}} = \dfrac{\ln 2}{2(\ln 2)} \times 20 = 10$ min

$\begin{array}{ccc} A & \longrightarrow & B \\ 1-x & & x/2 \end{array}$

$\begin{array}{ccc} A & \longrightarrow & C \\ 1-x & & x/2 \end{array}$

$(1-x)\,60 = \dfrac{x}{2} \times 40 + \times 80$

$x = 0.5$

Time in which reaction will be optically inactive = 10 min.   ]

28. 16

Sol. $\ln \dfrac{k_2}{k_1} = \dfrac{E_a}{R}\left[\dfrac{1}{T_1} - \dfrac{1}{T_2}\right]$;

$\ln\left(\dfrac{k_{310}}{k_{300}}\right) = \ln(e) = \dfrac{E_a}{R}\left[\dfrac{1}{300} - \dfrac{1}{310}\right]$

$\Rightarrow \dfrac{E_a}{R}\left[\dfrac{10}{300 \times 310}\right] = 1$; $E_a = \dfrac{300 \times 310 \times R}{10}$

$\therefore \ln\left(\dfrac{k_{620}}{k_{300}}\right) = \dfrac{300 \times 310 \times R}{10R}\left[\dfrac{1}{300} - \dfrac{1}{620}\right]$

$= 16$]

29. 4.0

Sol. $t_{1/2} = 3$ hours, $n = T/t_{1/2} = 18/3 = 6$.

$N = N_o\left(\dfrac{1}{2}\right)^n \Rightarrow N = 256\left(\dfrac{1}{2}\right)^6$

$\Rightarrow N = 256 \times \dfrac{1}{2} \times \dfrac{1}{2} \times \dfrac{1}{2} \times \dfrac{1}{2} \times \dfrac{1}{2} \times \dfrac{1}{2} = 4.0$ g

30. 32

Sol. $\dfrac{\text{Rate at } 50°C}{\text{Rate at } T_1°C} = (2)^{\frac{\Delta T}{T_1}} = (2)^{\frac{50}{10}} = 2^5$

$= 32$ times