Solutions to Workbook-4 [Chemistry] | Chemical Kinetics

Daily Tutorial Sheet	Level - 0

1. This is because the rate of reaction at any time depends upon the concentration of the reactants at that time which keep on decreasing with time

2. $k = A e^{\frac{-E_a}{RT}}$ Arrhenius equation

3. $H_2 + Br_2 \longrightarrow 2HBr$

Rate $= k[H_2][Br_2]^{1/2}$

Order $= 1\frac{1}{2}$

4. $k = A e^{\frac{-E_a}{RT}}$

$k = A e^{\circ} \Rightarrow k = A$ (Collision frequency)

Which means every collision results in product formation. Hence K is independent of T

5. Rate = $k[A]^{\circ}\ [B]^{\circ}$

6. The minimum extra energy absorbed by the reactant molecules so that their energy becomes equal to threshold value is called activation energy.

7. Units of Rate $= \text{mol}\,L^{-1}\,\text{sec}^{-1}$ Units of rate constant $= \dfrac{\text{mol}\,L^{-1}\,\text{sec}^{-1}}{\text{mol}^3\,L^{-3}} = \text{mol}^{-2}\,L^2\,\text{sec}^{-1}$

8. The slowest elementary step written in the mechanism of a complex reaction is the rate determining step.

9. **(i)** Rate of reaction is doubled **(ii)** no effect on reaction rate

10. $CH_3COOC_2H_5 + H_2O \rightleftharpoons CH_3COOH + C_2H_5OH$

Since $[H_2O]$ does not change largely

Rate = $k[CH_3COOC_2H_5]^1$

11. r = Rate = $k[A]^n$ ... (1)

$27r = k\ (3A)^n$ ... (2)

$27 = (3)^n \Rightarrow n = 3$

12. $t_{1/2} = 2\text{Hrs}$

After 75% completion, 2 half lives, $t_{1/2}$ is independent of initial concentration of reactant, reaction of 1st order.

13. Does not depend upon concentration at constant temperature.

14. $\frac{dx}{dt} = k \Rightarrow \int dx = k\int dt \Rightarrow \therefore x = kt + I$

$t = 0,\ x = 0$

$I = 0$

Hence $x = kt \Rightarrow t = \frac{x}{k}$ for completion $x = a$; $\boxed{t = a/k}$

15. Rate $= -\frac{d[x_2]}{dt} = -\frac{1}{3}\frac{d[y_2]}{dt} = \frac{1}{2}\frac{[xy_3]}{dt}$

Rate of disappearance of $y_2 = \frac{-d[y_2]}{dt} = \frac{-3d[x_2]}{dt} = +\frac{3}{2}\frac{[xy_3]}{dt}$

16. Rate = k $[NO]^2 [O_2]$

Let initially moles of NO = a

Moles of O_2 = b

Volume of vessel = 'V' L

Then $[NO] = \frac{a}{V} M$

$[O_2] = \frac{b}{V} M$

(r_1) rate $= k\left[\frac{a}{V}\right]^2\left[\frac{b}{V}\right] = \frac{ka^2b}{V^3}$

New volume = V/3

New concentration of $[NO] = \frac{a}{V/3} = \frac{3a}{V}$

New concentration of $O_2 = \frac{b}{V/3} = \frac{3b}{V}$

New rate $r_2 = k\left[\frac{3a}{V}\right]^2\left[\frac{3b}{V}\right] = \frac{27ka^2b}{V^3}$

$\frac{r_2}{r_1} = 27$

There is no effect on order of reaction

17. $t_{1/2} = 69.3\,\text{min}$

$k = \frac{0.693}{69.3} = 0.01\,\text{min}^{-1}$

$t_{80\%} = \frac{2.303}{k}\log\frac{[R_0]}{[R]}$

$= \frac{2.303}{0.01}\log\frac{R_0}{\frac{20}{100}R_0} = \frac{2.303}{0.01}\times\log 5$

$= \frac{2.303}{0.01}\times 0.6990 = 160.97\,\text{min} = 2.68\text{hrs.}$

18. Let T_1 = 300 K and T_2 = 310 K ; $E_a = 52000\ \text{Jmol}^{-1}$

$\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$

Putting values we get : $\boxed{k_2 = 2k_1}$

Thus the rate of reaction doubles after every 10°C rise in temperature

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

If E_a is –ve, $e^{-E_a/RT} = e^x$ where $x = \frac{E_a}{RT}$

$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} .....x <<< 1 + x = 1 + \frac{E_a}{RT}$

$k = A\left(1 + \frac{E_a}{RT}\right)$

$k >> A$

Which is impossible

Hence E_a is never negative.

20. Rate $= k[A][B]^2 = 2\times10^{-6}[0.1][0.2]^2$

$= 8\times10^{-9}\,\text{mol}L^{-1}\sec^{-1}$

$[A]_{Final} = 0.06\,\text{mol}\,L^{-1}$

Ratio of A to B is 2:1

$[B]_{Final} = 0.2 - \left(\dfrac{0.04}{2}\right) = 0.18\,\text{mol}\,L^{-1}$

Rate $= \left(2\times10^{-6}\right)(0.06)(0.18)^2$

$= 3.89\times10^{-9}\,\text{mol}\,L^{-1}\sec^{-1}$

21. $r_1 = \text{rate} = k[R]^2$

$r_2 = k[2R]^2 \Rightarrow r_2 = 4r_1$; $r_3 = k\left[\dfrac{R}{2}\right]^2 \Rightarrow r_3 = \dfrac{1}{4}r_1$

22. Fraction of molecules having energy equal to or greater than activation energy $x = e^{\frac{-E_a}{RT}}$

$\log x = \dfrac{-E_a}{2.303RT}$

$\log x = -\dfrac{209.5\times10^3}{2.303\times8.314\times581} = -18.8323$

$x = \text{anti}\log(-18.8323) = \text{anti}\log\left(\overline{19}.1677\right) = 1.47\times10^{-19}$

23. Rate $= k[A]^1[B]^0$

Exp. 1 : $2\times10^{-2} = k(0.1)^1[0.1]^0$

$k = 0.2\,\text{min}^{-1}$

Exp. 2 : $4\times10^{-2} = 0.2[A][0.2]^0$

$[A] = 0.2\,\text{mol}\,L^{-1}$

Exp. 3 : Rate $= 0.2\times0.4 = 0.08\,\text{mol}\,L^{-1}\,\text{min}^{-1}$

Exp. 4 : $2\times10^{-2} = 0.8[A] = 0.1\,\text{mol}\,L^{-1}$

24. $t_{1/2} = \dfrac{0.693}{k} \Rightarrow \dfrac{0.693}{5730}(\text{yr})^{-1} = k$

$t = \dfrac{2.303}{k}\log\dfrac{R_0}{R}$

$t = \dfrac{2.303}{\frac{0.693}{5730}}\log\dfrac{100}{80} = \dfrac{2.303\times5730}{0.693}\times0.0969\,\text{year}$

$= 1845\,\text{years}.$

25. $k = \dfrac{0.693}{t_{1/2}} = \dfrac{0.693}{28.1}\text{yr}^{-1} = 2.466\times10^{-2}\,\text{yr}^{-1}$

$k = \dfrac{2.303}{t}\log\dfrac{R_0}{R}$

$2.466\times10^{-2} = \dfrac{2.303}{10}\times\log\dfrac{1}{R}$

$\log R = -0.1071$

$R = \text{anti}\log\,\overline{1}.8929 = 0.7814$¼g.