Nishant Jindal

Kinetics

JEE-Adv

(2)

$A_f = 10^{15}$

$A_b = 10^{11}$

$\frac{1}{T} = 0.002$

$T = \frac{1000}{0.002} = 500K$

At 500K

$\log K = \log k_f - \log k_b$

$6 = 9 - \log k_b$

$\log k_b = 3$

$k_b = A_b e^{-(E_a)/RT}$

$\ln \frac{k_{b_2}}{k_{b_1}} = \frac{(E_a)_b}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

At 250K $|\log k_b| = ?$

At 500K $\log K = 6$

~~$\log k_f = \log A_f - \frac{E_a}{2.303R}\left(\frac{1}{T}\right)$~~

~~$9 = \log 10^{15} - \frac{E_a}{2.303R} \times 0.002$~~

~~At 500K $\log k_f = 9$~~

~~$k_f = 10^9$~~

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(II) $\text{Rate} = \dfrac{k[X]}{X_S + \cancel{[X]}}$ 1st order

(III) $\text{Rate} = \dfrac{k[X]}{\cancel{X_S} + [X]}$ zero order

(IV) $\text{Rate} = \dfrac{k[X]^2}{\cancel{X_S} + [X]}$ 1st order

(P)

(Q) 1st order

(R)

(S) Zero

(T) 1st order

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$$2X + Y \xrightarrow{k} P$$

$$\frac{d[P]}{dt} = k[X] = \frac{1}{2}\left(-\frac{d[X]}{dt}\right)$$

$$-\frac{d[X]}{dt} = 2k[X]$$

$$-\frac{d[X]}{dt} = k'[X]$$

$$t_{1/2} = \frac{\ln 2}{k'} = 50 \qquad k' = \frac{\ln 2}{50} = 2k$$

50 Sec

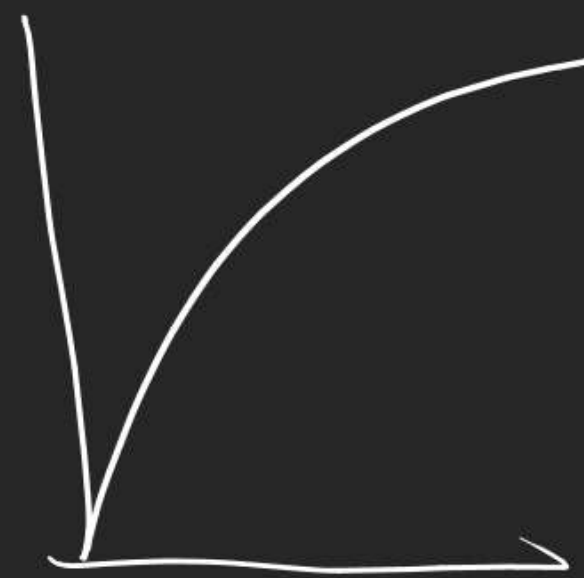
$$2X + Y \xrightarrow{k} P$$

	X	Y
	2	1
	1	0.5
at 100 Sec	0.5	0.25

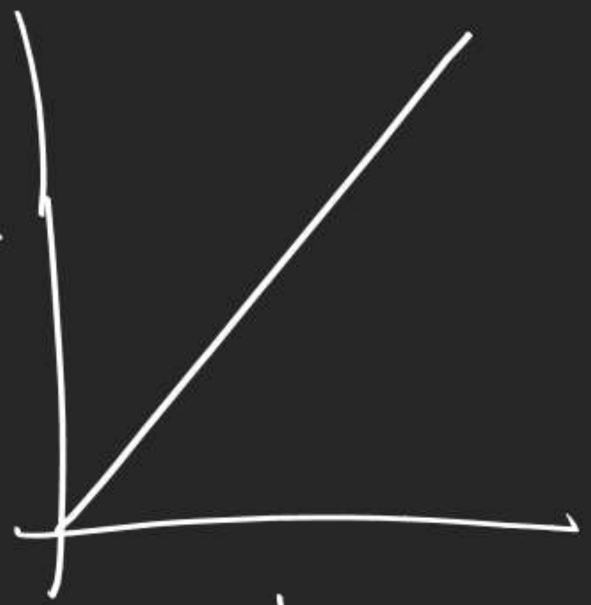
$$\ln \frac{[A]_0}{[A]_t} = kt$$

$$\ln \frac{[P]_0}{P_t} = kt$$

(c) $\dfrac{Q}{[P]_0}$



$\ln \dfrac{P_0}{P}$



time

(6) $k_r = \dfrac{k_A}{2} = 5 \times 10^{-4}$

$$\boxed{k_A = 10^{-3}}$$

(7)

$$A \longrightarrow 2B(g) + C(g)$$

P_0		
$P_0 - x$	$2x$	x
0	$2P_0$	P_0

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find $[H^+]$ & pH of

(1) $0.1M\ CH_3COOH$ $(K_a = 10^{-5})$

(2) $10^{-5}M\ CH_3COOH$ $(K_a = 10^{-5})$

Case-I

$\boxed{\text{if } C \geq 10^{-6} \text{ \& } K_aC \geq 10^{-12}}$

(1) $CH_3COOH \longrightarrow CH_3COO^- + H^+$

$0.1 - x \qquad x \qquad x$

$$K_a = \frac{x^2}{0.1 - \cancel{x}} = 10^{-5}$$

$$\frac{K_a}{C} = \frac{10^{-5}}{0.1} = 10^{-4}$$

$$x = 10^{-3} = [H^+]$$

$$pH = 3$$

$$x^2 + 10^{-5}x - 10^{-6} = 0$$

$$x = \frac{-10^{-5} + \sqrt{\cancel{10^{-10}} + 4\times10^{-6}}}{2}$$

$$= \frac{-10^{-5} + 200\times10^{-5}}{2}$$

$$= \frac{199\times10^{-5}}{2} = 99.5\times10^{-5}$$

$$= 0.995\times10^{-3}$$

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2

$$10^{-5} = \frac{x^2}{10^{-5} - x}$$

$$\cancel{\frac{K_a}{C} = 1}$$

$$x = 0.62 \times 10^{-5}$$

$$[H^+] = 0.62 \times 10^{-5}$$

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Case-II In rest all the cases

$[H^+]$ due to water can not be neglected

$$HA \longrightarrow H^+ + A^-$$
$$c-x \qquad x+y \qquad x$$

$$K_a = \frac{(x+y)(x)}{c-\cancel{x}}$$

if $K_a/c \leq 10^{-3}$

$$H_2O \longrightarrow H^+ + OH^-$$
$$y+x \qquad y$$

$$K_w = (x+y)(y)$$

$$K_a c = (x+y)(x)$$

$$\sqrt{K_a c + K_w} = (x+y) = [H^+]$$

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Case-III

if $K_a/C > 100$ then WA can be treated as SA

$10^{-5}M$ HA $(K_a = 10^{-2}M)$ $\quad \alpha = ?$

$$HA \longrightarrow H^+ + A^-$$
$$C(1-\alpha) \qquad C\alpha \qquad C\alpha$$

$$10^3 \quad \cancel{10^{-2}} = \frac{C\alpha^2}{1-\alpha} = \frac{\cancel{10^{-5}}\alpha^2}{1-\alpha}$$

$$\alpha^2 + 10^3\alpha - 10^3 = 0$$

$$\alpha = \frac{-10^3 + \sqrt{10^6 + 4\times10^3}}{2}$$

$$= \frac{-10^3 + 10^3(1+4\times10^{-3})^{1/2}}{2}$$

$$= \frac{-\cancel{10^3} + 10^3(\cancel{1} + \frac{1}{2}\times4\times10^{-3})}{2}$$

$$\alpha = 1$$

$10^{-5}M$ HA $(K_a = 10^{-2}M) \Rightarrow$ $10^{-5}M$ HCl

$$[H^+] = 10^{-5}M$$

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① $10^{-2}M$ HA $(K_a = 10^{-6}M)$ Case – I

② $10^{-4}M$ HA $(K_a = 10^{-10}M)$ Case – II

③ $10^{-4}M$ HA $(K_a = 10^{-4}M)$ Case – I

④ $10^{-7}M$ HA $(K_a = 10^{-4}M)$ Case – II

Weak acid → strong

$10^{-7}M\ HCl$

$H_2O \longrightarrow H^+ + OH^-$

$(10^{-7}+x)(x) = 10^{-14}$

$x = 0.62\times10^{-7}$ $[H^+] = 1.62\times10^{-7}$ → 6.78

①

$K_a/C = 10^{-4} < 10^{-3}$ $10^{-6} = \dfrac{x^2}{10^{-2}-\cancel{x}}$

$x = 10^{-4}$ pH = 4

②

$\sqrt{K_aC + K_w} = [H^+]$

$\sqrt{10^{-10}\times10^{-4} + 10^{-14}} = \sqrt{2}\times10^{-7} = [H^+]$

$pH = 7 - \log\sqrt{2}$

$= 6.85$

③

$10^{-4} = \dfrac{x^2}{10^{-4}-x}$ $x = 0.62\times10^{-4}$

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$$K_a = \frac{x^2}{C - x}$$

$$K_a = 10^{-5}$$

$pH = 3$ $\quad [H^+] = 10^{-3} = x$

$C = ?$

$K_a \quad C \quad x$

$pH = 5$

Ionic

$\boxed{S - I \quad S - 14}$