

## Topic :- Chemical Kinetics

1 (a)

$$K = \frac{2.303}{k} \log \frac{a}{(a-x)}$$
$$= \frac{2.303}{40} \log \frac{0.1}{0.025} = 0.0347$$
$$\therefore r = K \times [A] = 0.0347 \times 0.01$$
$$= 3.47 \times 10^{-4} \text{ M/min}$$

3 (b)  
For zero order reaction

$$x = kt$$

$$= 0.2 \text{ mol dm}^{-3} \text{ h}^{-1} \times \frac{30}{60} \text{ h}$$

$$= 0.1 \text{ mol dm}^{-3}$$

$$\text{Now, concentration} = 0.05 \text{ mol dm}^{-3}$$

$$\text{Hence, initial concentration} = 0.1 + 0.05 = 0.15 \text{ mol dm}^{-3}$$

4 (c)  
For the reaction,  
 $2X + Y \rightarrow Z$

$$\text{Rate} = -\frac{1}{2} \frac{d[X]}{dt} = \frac{d[Z]}{dt}$$
$$= 0.05 \text{ mol L}^{-1} \text{ min}^{-1}$$
$$-\frac{1}{2} \frac{d[X]}{dt} = 0.05$$
$$-\frac{d[X]}{dt} = 2 \times 0.05$$
$$= 0.1 \text{ mol L}^{-1} \text{ min}^{-1}$$

5 (b)  
 $X(g) \rightarrow Y(g) + Z(g)$   
The reaction is a first order reaction.

Hence ,

$$k = \frac{0.693}{t_{1/2}} = \frac{2.303}{t} \log \frac{a}{(a-x)}$$

$$0.2234 \frac{0.693}{10} = \frac{2.303}{t} \log \frac{a}{a/10}$$

$$\text{Or } t = \frac{2.303 \times 10}{0.693} \times \log 10 \\ = 33 \text{min}$$

6 **(a)**

To be solved with the help of formula,

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

$$T_1 = 273 + 27 = 300 \text{ K}$$

$$T_2 = 273 + 67 = 340 \text{ K}$$

$$\log \frac{6.9 \times 10^{-3}}{3.45 \times 10^{-5}} = \frac{E_a}{2.303 \times 8.31} \left[ \frac{340 - 300}{340 \times 300} \right]$$

$$\log 200 = \frac{E_a}{19.1379} \times \frac{40}{102000}$$

$$2.3010 = \frac{E_a}{19.14} \times \frac{4}{10200}$$

$$E_a = \frac{19.14 \times 10200 \times 2.3010}{4}$$

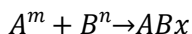
$$= 112304.907 \text{ J} = 112.3 \text{ kJ}$$

7 **(c)**

$\frac{dx}{dt} = K(a-x)^2$  is differential form of II order.

Integrate it to get (c).

8 **(d)**



In this case,

Overall order of reaction =  $m + n$

Hence, code 3 is wrong

9 **(a)**

For the first order reaction,

$$t_{1/2} = \frac{1}{k}$$

$$\text{Or } t_{1/2} = \frac{0.693}{k}$$

10 **(d)**

Order of reaction is an experimentally determined quantity and thus, cannot be predicted from the given equation.

11 **(b)**

The rate for first order reaction is expressed as

$A \rightarrow \text{products}$

$$\text{Rate} = - \frac{d[A]}{dt}$$

$$\text{Rate} = k[A]$$

And the rate constant (k) is given as

$$k = \frac{2.303}{t} \log \frac{[A_0]}{[A_t]}$$

$$\text{or } -k = \frac{t}{2.303} \log \frac{[A_t]}{[A_0]}$$

12 **(d)**

$$t_{1/2} = \frac{1}{(a)^{n-1}}$$

Where, n = order of reaction

a = initial concentration

For first order reaction,

$$n = 1$$

$$t_{1/2} = \frac{1}{a^{n-1}}$$

$$a = \frac{1}{a^0} = 0$$

Thus for a first order reaction,  $t_{1/2}$  is independent of initial concentration.

13 **(b)**

Relation between ( $t_{1/2}$ ) and initial concentration of reactant for ( $n - 1$ ) order reaction

$$t_{1/2} \propto [R]_0^{2-n}$$

14 **(a)**

$$K = \frac{2.303}{40} \log \frac{0.1}{0.025}$$

$$\therefore K = 0.03466 \text{ min}^{-1}$$

$$\text{rate} = K \times 0.01 = 0.03466 \times 0.01 = 3.47 \times 10^{-4} \text{ M min}^{-1}$$

15 **(c)**

Rate of endothermic reactions increase with increase in temperature while that of exothermic reactions decrease with increasing temperature.

16 **(d)**

$$k = \frac{2.303}{t} \log_{10} \frac{a}{a-x}$$

For half-life period,  $x = \frac{a}{2}$

$$t = \frac{2.303}{k} \log_{10} \frac{a}{a - \frac{a}{2}}$$

$$t = \frac{2.303}{k} \log_{10} 2$$

$$\therefore t = t_{1/2}$$

$$t_{1/2} = \frac{2.303 \times 0.3010}{k}$$

$$t_{1/2} = \frac{0.693}{k}$$

17 (d)

∴ Rate constant ( $k'$ ) > rate constant ( $k''$ )

Greater the rate constant lesser will be the activation energy

$$\therefore E'_a < E''_a$$

18 (d)

The reactant concentration drop from 0.8 to 0.4 M, i.e., 50% takes place in 15 minute.

$$K = \frac{2.303}{15} \log \frac{0.8}{0.4} = \frac{0.693}{15} = 0.0462 \text{ min}^{-1}$$

$$\text{Also, } t = \frac{2.303}{K} \log \frac{0.1}{0.025} = \frac{2.303}{0.0462} \log \frac{0.1}{0.025} = 30 \text{ min}$$

19 (c)

$$\text{For II order, } t = \frac{1}{Ka} \frac{x}{(a-x)}$$

$$\therefore t = \frac{1}{8 \times 10^{-5} \times 1} \left( \frac{0.5}{0.5} \right) = 1.25 \times 10^{-4} \text{ minute}$$

20 (a)

The Arrhenius equation can be written as

$$\log k = \log A - \frac{E_a}{2.303 RT}$$

On comparing this equation with standard equation of straight line

$y = mx + c$ , we get,

$$y = \log k$$

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

$$m = -\frac{E_a}{2.303R}$$

$$c = \log A$$

Hence, on plotting graph between  $\log k$  ( $y$ -axis) and  $\frac{1}{T}$  ( $x$ -axis), we get a line with slope equal to

$$m = -\frac{E_a}{2.303 R}$$

| <b>ANSWER-KEY</b> |           |           |           |           |           |           |           |           |           |           |
|-------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>Q.</b>         | <b>1</b>  | <b>2</b>  | <b>3</b>  | <b>4</b>  | <b>5</b>  | <b>6</b>  | <b>7</b>  | <b>8</b>  | <b>9</b>  | <b>10</b> |
| <b>A.</b>         | <b>A</b>  | <b>B</b>  | <b>B</b>  | <b>C</b>  | <b>B</b>  | <b>A</b>  | <b>C</b>  | <b>D</b>  | <b>A</b>  | <b>D</b>  |
|                   |           |           |           |           |           |           |           |           |           |           |
| <b>Q.</b>         | <b>11</b> | <b>12</b> | <b>13</b> | <b>14</b> | <b>15</b> | <b>16</b> | <b>17</b> | <b>18</b> | <b>19</b> | <b>20</b> |
| <b>A.</b>         | <b>B</b>  | <b>D</b>  | <b>B</b>  | <b>A</b>  | <b>C</b>  | <b>D</b>  | <b>D</b>  | <b>D</b>  | <b>C</b>  | <b>A</b>  |
|                   |           |           |           |           |           |           |           |           |           |           |

**PE**