Chemical kinetics

1) For the rxn $R \rightarrow P$, the concn of rktnt changes from 0.03M to 0.02M in 25 mints. Calculate the average rate of rxn using unit of time both in mints and sec.

Ans:- The average rate $= \frac{-\Delta[R]}{\Delta t} = -\frac{[R_2]-[R_1]}{t_2-t_1}$.

$= -\frac{0.02M - 0.030M}{25 min} = \frac{-0.01M}{25 min}$

$= 4 \times 10^{-4} M min^{-1}$

$= \frac{0.01M}{25 \times 60 s} = 6.66 \times 10^{-6} M s^{-1}$.

2) In a rxn $2A \rightarrow$ Products, concn of A decreases from $0.5 mol L^{-1}$ to $0.4 mol L^{-1}$ in 10 mints. Calculate the rate during this interval.

Rate of rxn = Rate of disappearance of A.

$= -\frac{1}{2}\frac{\Delta[A]}{\Delta t} = -\frac{1}{2}\frac{(0.4-0.5) mol L^{-1}}{10 min}$

$= 0.005 mol L^{-1} min^{-1}$.

3) Order For a rxn $A + B \rightarrow P$, the rate law is given by $r = k[A]^{\frac{1}{2}}[B]^2$. What is the order of rxn.

$$\text{Order of rxn} = \frac{1}{2} + 2 = \frac{5}{2}.$$

4) The coversion of the molecule X to Y follows second order kinetics. If the concn X is increased to three times, how will it affect the rate of formation of Y?

$$\text{Rate} = k[X]^2.$$

$$r_1 = k[X]^2$$

$$r_2 = k[3X]^2$$

$$\frac{r_2}{r_1} = \frac{9\cancel{k}[\cancel{X}]^2}{\cancel{k}[\cancel{X}]^2}$$

$$r_2 = 9r_1.$$

The rate of formation of Y will increase by 9 times.

5) A first order rxn has a rate constant $1.15 \times 10^{-3}\ s^{-1}$. How long will 5g of this rktnt take to reduce to 3g?

Given:- $[R]_0 = 5g$, $[R] = 3g$.

$$k = 1.15 \times 10^{-3}\ s^{-1}.$$

[illegible]

[illegible]

[illegible]

[illegible]

3) Time reqd to decompose SO_2Cl_2 to half of its initial amt is 60 min. If decomposition is a first order, calculate the rate constant of the

For a first order rxn, $k = \frac{0.693}{t_{1/2}}$

$= \frac{0.693}{60\,min} = 1.155\times10^{-2}$

4) The rate of a chemical rxn doubles for an increase of 10K in absolute Temp from 298 K. Calc

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

$$E_a = 2.303R \log \frac{K_2}{K_1} \left[\frac{T_1 T_2}{T_2 - T_1}\right]$$

$$= (2.303)(8.314\,JK^{-1}mol^{-1})\left[\log \frac{2}{1}\right] \times \left[\frac{298K \times 308K}{308K - 298K}\right]$$

$$= 52898\,J\,mol^{-1} = 52.9\,kJ\,mol^{-1}.$$

8) The activation energy of reaction, $2HI \rightarrow H_2 + I_2$, is $209.5\,kJ\,mol^{-1}$ at 581K. Calculate the fraction of molecules of reactants having energy equal to or greater than activation energy.

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

$$\ln x = \frac{-E_a}{RT}.$$

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

$$\log x = -\frac{209.5 \times 10^{3}\,J\,mol^{-1}}{2.303 \times 8.314\,JK^{-1}\,mol^{-1} \times 581K} = -18.8323$$

$$x = \text{Antilog}(-18.8323)$$

For antilog of negative no, ~~add and~~ substract 1 like below -

$1 - 0.8323 - 1 - 18$

$0.1677 - 19$

$-19 + 0.1677$. antilog $0.1677 = 1.47$

Now see table

1.471×10^{-19}

-19 becomes 10^{-19}