Answer on Question #77094 - Chemistry - Physical Chemistry

Question:

b) For a reaction of the type:

B Products

the initial rate of the reaction (i.e. the rate at time t = 0; denoted Ro) Was measured at T=298 K for different values of the initial concentration of the reactant B (denoted [B]o). The measured data are:

[B]o / mol dm—3	3.0	6.0	9.0	12.0	1 5.0
Ro / mol dms s- 1	21.8	87.1	1 96	348	545

Using the method of initial rates and drawing an appropriate graph, determine the order of the reaction and the value of the rate constant for the reaction at T -- 298 K.

Solution:

A reaction is said to be first order if its rate is determined by the change of one concentration term only. One can say that a first order reaction is one whose rate varies as 1st power of the concentration of the reactant i.e. the rate increases as number of times as the number of times the concentration of reactant is increased.

Consider the reaction

A → products

Let $[A]_O$ = Initaial Concentration of A

$[A]_t$ = The concentration of A after time t

For the reaction to be of first order..

$$Rate = -\frac{d[A]]}{dt} = k[A] \Rightarrow \frac{d[A]}{[A]} = -kdt \quad \text{...(i)}$$

Intigrating this equation

$$\int_{[A]_o}^{[A]} \frac{d[A]}{[A]} = -k \int_0^t dt$$

we get

$\ln [A] - \ln[A]_o = -K(t-0)$

$$ln\frac{[A]}{[A]_o} = -kt$$

$$\Rightarrow ln\frac{[A]_o}{[A]} = kt$$

$$\Rightarrow log\frac{[A]_o}{[A]} = \frac{kt}{2.303}$$

$$\Rightarrow k = \frac{1}{t}ln\frac{[A]_o}{[A]}$$