Exponential function:

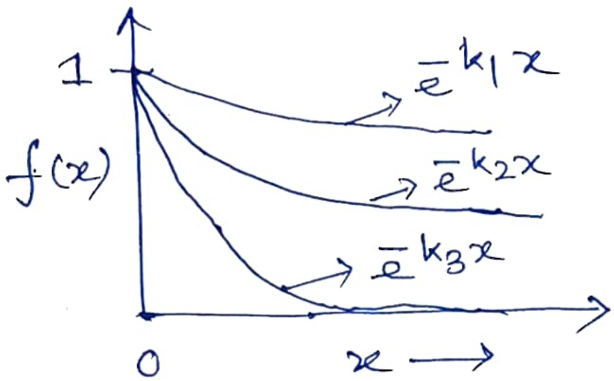
$f(x) = e^{-kx}$

$$e^{-kx} = \frac{1}{e^{kx}} = \frac{1}{e^{0}} = \frac{1}{1} = 1$$

(When $x = 0$ or $k = 0$)

$$e^{-kx} = \frac{1}{e^{kx}} = \frac{1}{e^{\infty}} = \frac{1}{\infty} = 0$$

(When $x = \infty$ or $k = \infty$)



$k_3 > k_2 > k_1$

We use the above properties of the exponential function in our derivation:

$$A \xrightarrow{k_1} X \xrightarrow{k_2} Z$$

$$[X] = [A]_0 \frac{k_1}{k_2 - k_1}\left(e^{-k_1 t} - e^{-k_2 t}\right)$$

Steady-State Treatment:

k_2 is large

k_1 is very very small

$k_2 \ggg k_1$

Then $k_2 - k_1 \approx k_2$

Therefore,

$$[X] = [A]_0 \frac{k}{k_2}\left(e^{-k_1 t} - e^{-k_2 t}\right)$$

Assume

$k_2 = 10\ s^{-1}$

$k_1 = 0.001\ s^{-1}$

$10 - 0.001 \approx 10$

Now concentrate on the quantity

$$\left(e^{-k_1 t} - e^{-k_2 t}\right)$$

At $t=0$, $e^{-k_1 t} = e^{-k_1 0} = e^{-0} = 1$

and $e^{-k_2 t} = e^{-k_2 0} = e^{-0} = 1$

Therefore, $\left(e^{-k_1 t} - e^{-k_2 t}\right) = (1-1) = 0$

"

$$[x] = [A]_0 \frac{k_1}{k_2}\left(e^{-k_1 t} - e^{-k_2 t}\right)$$

$$= [A]_0 \frac{k_1}{k_2}(1-1) = 0 \quad (\text{at } t=0)$$

After very short time, relative to the duration of the reaction,

$$e^{-k_1 t} - e^{-k_2 t} \approx 1$$

$$\approx e^{-0.001\times 10} - e^{-10\times 10}$$

$$\approx 0.99 - 10^{-44}$$

$$\approx 0.99 - 0 \approx 0.99$$

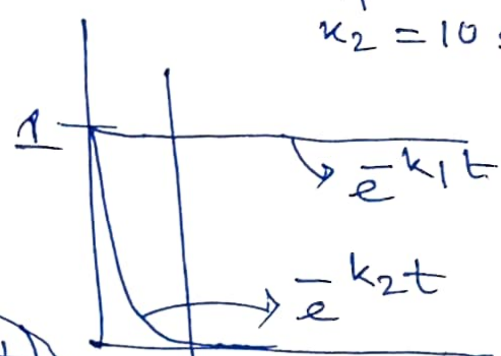
$$\approx 1$$

Follow the plot on the first page.

$k_2 >> k_1$ and

$k_1 = 0.001 s^{-1}$

$k_2 = 10 s^{-1}$



$$[x] = [A]_0 \frac{k_1}{k_2}\left(e^{-k_1 t} - e^{-k_2 t}\right)$$

$$= [A]_0 \frac{k_1}{k_2}$$

Since $\frac{k_1}{k_2} << 1$

$[x] << [A]_0$

Again $[A]_0$, k_1, k_2 are constants

after this time change of $[x]$ is constant