$$\frac{1}{1-X_A} - 1 = C_{A0} k t$$

$$\frac{1 - (1-X_A)}{1-X_A} = C_{A0} k t$$

$$\frac{X_A}{1-X_A} = C_{A0} k t$$

$$\Downarrow$$

$$\boxed{X_A = \frac{C_{A0} k t}{1 + C_{A0} k t}}$$

FOR $\gamma = 1$

IF $\gamma \neq 1$

$$\frac{dX_A}{dt} = C_{A0} k (1 - X_A)(\gamma - X_A)$$

$$\int_0^{X_A} \frac{dX_A}{(1 - X_A)(\gamma - X_A)} = \int_0^t C_{A0} k \, dt = C_{A0} k t$$

PARTIAL FRACTIONS...

$$\frac{1}{(1 - X_A)(\gamma - X_A)} = \frac{A_1}{1 - X_A} - \frac{A_2}{\gamma - X_A}$$

$\hookrightarrow \quad A_1 = \frac{1}{\gamma - 1} \qquad A_2 = \frac{1}{\gamma - 1}$

$$\int_0^{x_A} \frac{dx_A}{(1-x_A)(\gamma-x_A)} = \frac{1}{\gamma-1}\int_0^{x_A} \frac{dx_A}{1-x_A} - \frac{1}{\gamma-1}\int_0^{x_A} \frac{dx_A}{\gamma-x_A}$$

$$-\frac{1}{\gamma-1}\ln\left[\frac{1-x_A}{1}\right] + \frac{1}{\gamma-1}\ln\left[\frac{\gamma-x_A}{\gamma}\right]$$

$$\ln\left[\frac{\gamma-x_A}{\gamma}\right] - \ln\left[1-x_A\right] = (\gamma-1)\,C_{A0}kt$$

$$= \left(\frac{C_{B0}}{C_{A0}}-1\right)C_{A0}kt$$

$$= \underbrace{(C_{B0}-C_{A0})k}\,t = qt$$

$$\ln\left[\frac{\gamma - x_A}{\gamma(1-x_A)}\right] = qt$$

$$\frac{\gamma - x_A}{\gamma(1-x_A)} = e^{qt}$$

$$\gamma - x_A = \gamma(1-x_A)e^{qt}$$

$$= \gamma e^{qt} - \gamma x_A e^{qt}$$

$$x_A\left[\gamma e^{qt} - 1\right] = \gamma x_A e^{qt} - x_A = \gamma e^{qt} - \gamma = \gamma\left[e^{qt} - 1\right]$$

$$\boxed{x_A = \frac{\gamma\left[e^{qt}-1\right]}{\gamma e^{qt}-1}}$$

$\gamma \neq 1 \quad \left(\frac{C_{B0}}{C_{A0}}\right)$

4) SECOND ORDER (BIMOLECULAR) IRREVERSIBLE

SINGLE REACTION STOICHIOMETRY 2:3

$$2A + 3B \Rightarrow C$$

$$R_A = \frac{dc_A}{dt} = -k c_A c_B$$

⋮ USING FRACTIONAL CONVERSIONS

$$\frac{dX_A}{dt} = k(1-X_A)c_{B0}(1-X_B)$$

$$2A + 3B \rightarrow C$$

WHAT IS RELATIONSHIP BETWEEN X_A & X_B?

WRITE A TABLE

THINK ABOUT IT!

	A	B	
$n_{A0} \rightarrow$	100	100	$\leftarrow n_{B0}$
	98	97	
	90	85	
	⋮	⋮	
	40	10	

IN THIS CASE "B" IS LIMITING REACTANT

$$3\left[\begin{array}{c}\text{MOLES OF "A"}\\ \text{WHICH HAVE}\\ \text{REACTED}\end{array}\right] = 2\left[\begin{array}{c}\text{MOLES OF "B"}\\ \text{WHICH HAVE}\\ \text{REACTED}\end{array}\right]$$

FOR EXAMPLE

A	B
100	100
40	10

$$3[100-40] = 2[100-10] \quad \checkmark$$

$$3[n_{Ao}-n_A] = 2[n_{Bo}-n_B]$$

$$3(c_{A0} - c_A) = 2(c_{B0} - c_B)$$

$$3(c_{A0} - c_{A0}(1-x_A)) = 2(c_{B0} - c_{B0}(1-x_B))$$

$$3c_{A0}(1 - 1 + x_A) = 2c_{B0}(1 - 1 + x_B)$$

$$\boxed{3c_{A0}x_A = 2c_{B0}x_B}$$

Relationship between x_A & x_B

$$\text{let} \quad \gamma = \frac{2c_{B0}}{3c_{A0}} \longrightarrow x_B = \frac{1}{\gamma}x_A$$

$$\frac{dX_A}{dt} = k(1-X_A)C_{B0}(1-X_B)$$

$$\frac{dX_A}{dt} = k(1-X_A)C_{B0}\left(1-\frac{1}{\gamma}X_A\right)$$

$$\frac{dX_A}{dt} = k\left(\frac{C_{B0}}{\gamma}\right)(1-X_A)(\gamma-X_A)$$

NEW PART OF EQUATION

IF $\underline{\gamma=1}$

$$X_A = \frac{k(C_{B0}/\gamma)t}{1+(C_{B0}/\gamma)kt} = \frac{\frac{3}{2}kC_{A0}t}{1+\frac{3}{2}kC_{A0}t}$$

IF $\gamma \neq 1$

$$\ln\left[\frac{\gamma - x_A}{\gamma(1-x_A)}\right] = (\gamma-1)\left(\frac{C_{B0}}{\gamma}\right)kt$$

$$= \underbrace{\left(C_{B0} - \frac{3}{2}C_{A0}\right)kt}$$

$$\downarrow$$

$$\ln\left[\frac{\gamma - x_A}{\gamma(1-x_A)}\right] = qt$$

OR

$$\boxed{X_A = \frac{\gamma\left[e^{qt}-1\right]}{\left[\gamma e^{qt}-1\right]}}$$

WHERE $\gamma = \frac{2C_{B0}}{3C_{A0}}$ & $q = \left(C_{B0} - \frac{3}{2}C_{A0}\right)k$

FOR $\gamma \neq 1$