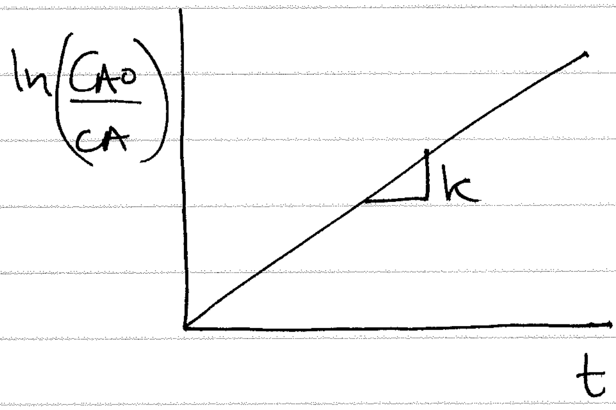
$$\therefore \quad \boxed{\ln\left(\frac{C_{A0}}{C_A}\right) = kt}$$




* How do you use this plot?

If you plot $\ln\left(\frac{C_{A0}}{C_A}\right)$ versus time & get a straight line $\Rightarrow$ the rxn. is 1st order in A

2nd order case:

$$\frac{dC_A}{dt} = -k C_A^2$$

$$\frac{dC_A}{C_A^2} = -k\,dt$$

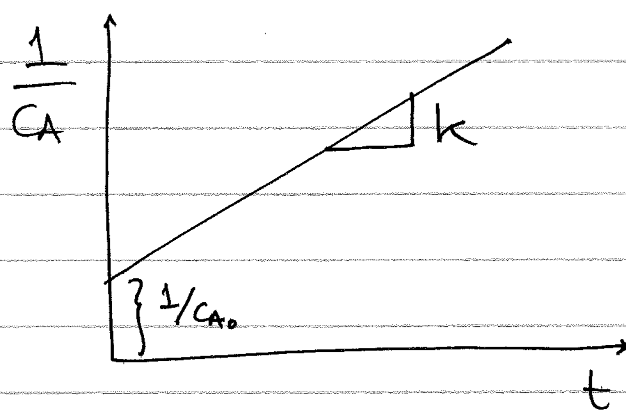
$$\therefore \quad \frac{\left(C_A^{-2+1}\right)}{(-2+1)} = -kt + C$$

$$\therefore \quad \frac{-1}{C_A} = -kt + C$$

$$\therefore \quad \frac{-1}{C_{A0}} = C$$

$$\therefore \quad \frac{-1}{C_A} = -kt - \frac{1}{C_{A0}}$$

$$\boxed{\therefore \quad \frac{1}{C_A} = kt + \frac{1}{C_{A0}}}$$




3rd order rxn. : $\quad \frac{dC_A}{dt} = -kC_A^{\,3}$

$$\therefore \quad \frac{dC_A}{C_A^{\,3}} = -k\,dt$$

$$\therefore \quad \left(\frac{C_A^{\,-3+1}}{-3+1}\right) = -kt + C$$

$$\frac{-1}{2C_A^2} = -kt + C$$

$$\therefore \frac{-1}{2C_A^2} = -kt - \frac{1}{2C_{A_0}^2}$$

$$\boxed{\therefore \frac{1}{2C_A^2} = kt + \frac{1}{2C_{A_0}^2}}$$

For an $n^{th}$ order rxn, $n \neq 1$

$$\frac{dC_A}{C_A^n} = -kt$$

$$\therefore \frac{C_A^{-n+1}}{(1-n)} = -kt + C$$

$$\frac{-(n-1)^{-1}}{C_A^{n-1}} = -kt + C$$

$$\boxed{\therefore \frac{(n-1)^{-1}}{C_A^{n-1}} = kt + \frac{(n-1)^{-1}}{C_{A_0}^{n-1}}}$$

$$\therefore \boxed{\frac{1}{(n-1)\,C_A^{n-1}} = kt + \frac{1}{(n-1)\,C_{A_0}^{n-1}}} \quad *$$

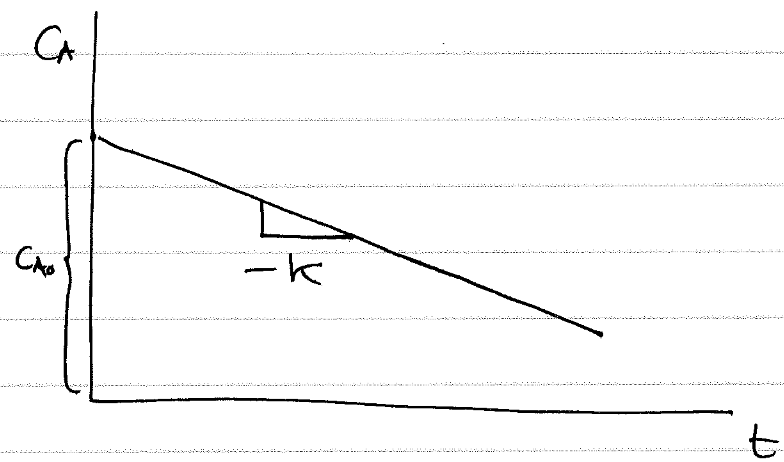
What about $0^{th}$ order?

$$\frac{dC_A}{dt} = -k$$

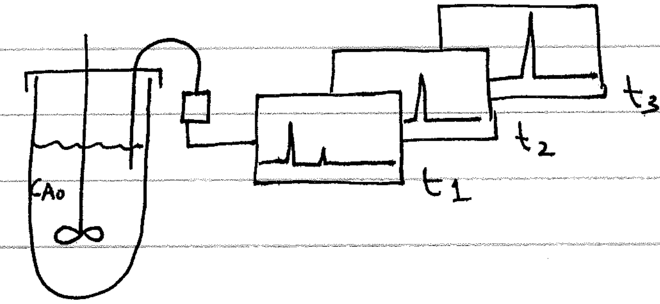
$$\therefore \quad C_A = -kt + C$$

$$\therefore \quad C_A = -kt + C_{A_0}$$

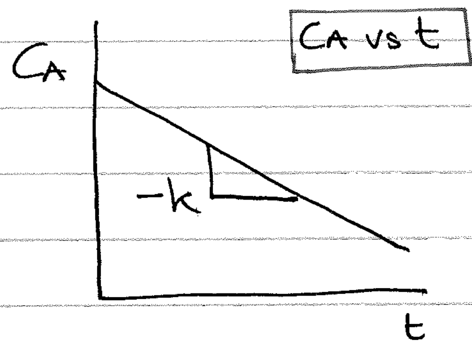
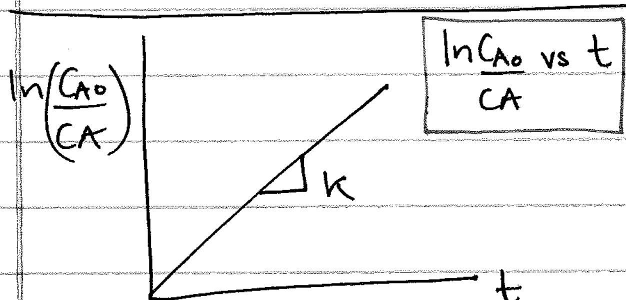
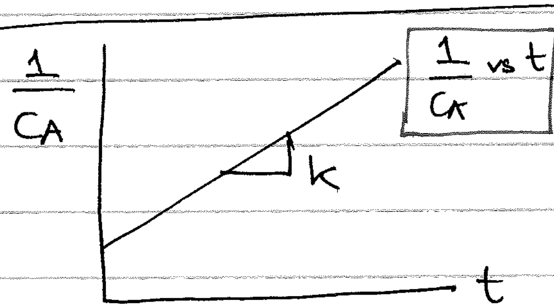
$$\boxed{\therefore \quad C_A = C_{A_0} - kt}$$



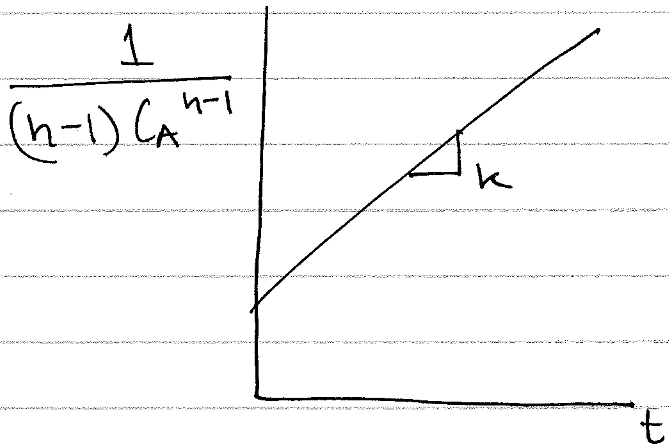

These results show that we can guess the order of the reaction very quickly using Excel.

∴ 


| $t$ | $0$ | ----- | time of sample |
|---|---|---|---|
| $C_A$ | $C_{A0}$ | ----- | measured conc. |

| Plot | Order |
|---|---|
|   | $0^{th}$ order |
|   | $1^{st}$ order |
|   | $2^{nd}$ order |

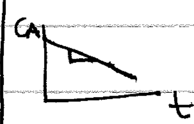
Contd.




Higher order

Algorithm:

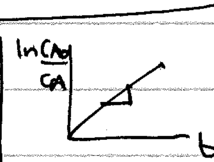
Plot $C_A$ vs t




? $\xrightarrow{\text{Yes}}$ $0^{th}$ order

↓ No

Plot $\ln\left(\frac{C_{A0}}{C_A}\right)$ vs t




? $\xrightarrow{\text{YES}}$ $1^{st}$ order

↓ No

Plot $\frac{1}{C_A}$ vs t

↓ & continue until you find the solution.