Solutions Assignment 7

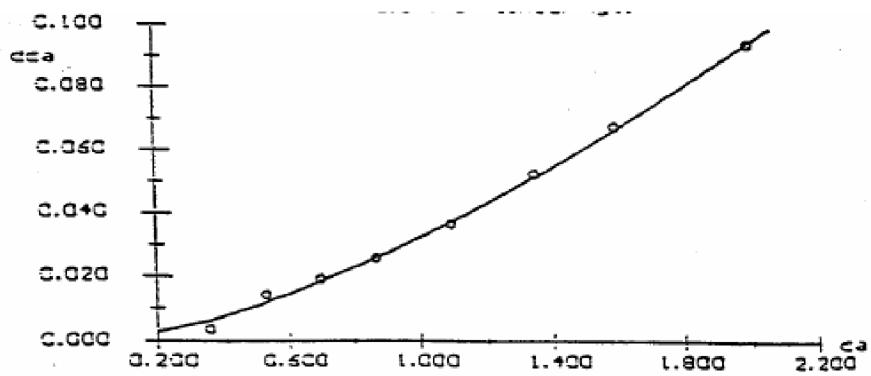
Problem 1.

$$\frac{dC_A}{dt} = kC_A^n$$

From a non - linear fit, we get

$k = 0.033$

$n = 1.54$



Model: cca = k*(ca^n)
k = 0.0326929
n = 1.53985
4 positive residuals, 4 negative residuals. Sum of squares = 1.49367e-05

Problem 2

t(min)	10	20	30	40	50	60
C_A(ppm)	2.45	1.74	1.23	0.88	0.62	0.44

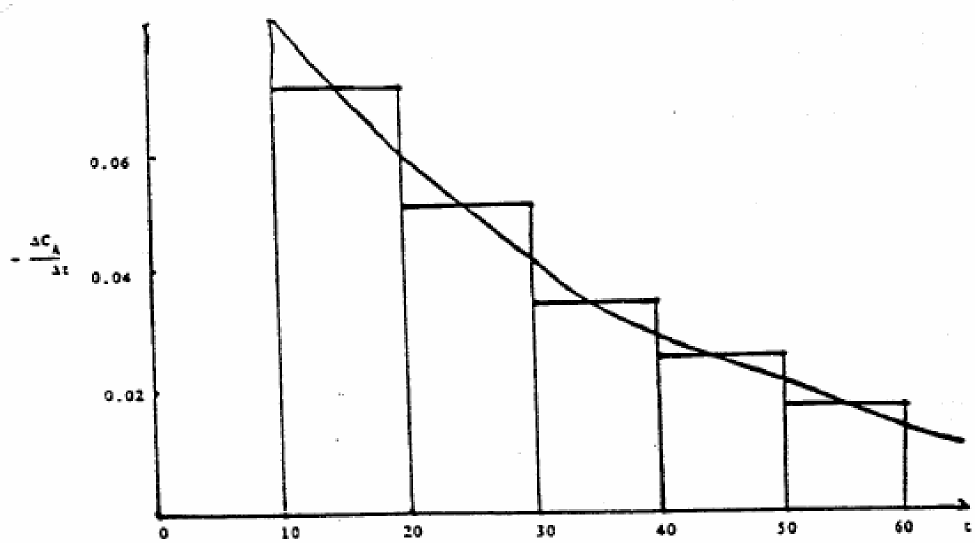
(a) Mole Balance: constant V

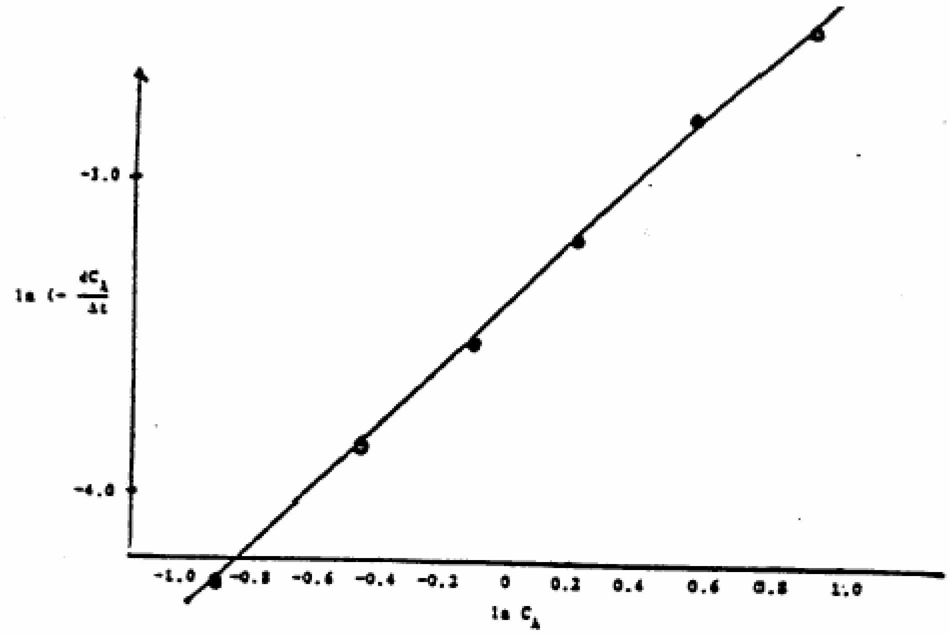
$$\frac{dC_A}{dt} = r_A = -k\ C_A^{\alpha}$$

$$\ln\left(-\frac{dC_A}{dt}\right) = \ln k + \alpha \ln C_A$$

Differentiation

t(min)	10		20		30		40		50		60
Δt(min)		10		10		10		10		10	
C_A(ppm)	2.45		1.74		1.23		0.88		0.62		0.44
ΔC_A(ppm)		-0.71		-0.51		-0.35		-0.26		-0.18	
$\frac{\Delta C_A}{\Delta t}\left(\frac{ppm}{min}\right)$		-0.071		-0.051		-0.035		-0.026		-0.018	





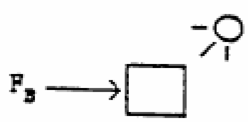
After plotting and differentiating by equal area

$-dC_A/dt$	0.082	0.061	0.042	0.030	0.0215	0.014
$\ln(-dC_A/dt)$	-2.501	-2.797	-3.170	-3.507	-3.840	-4.269
$\ln C_A$	0.896	0.554	0.207	-0.128	-0.478	-0.821

Using linear regression: $\alpha = 1.0$

$\ln k = -3.3864 \rightarrow k = 0.0344\ \text{min}^{-1}$

(b)



$$\frac{dVC_A}{dt} = Vr_A = F_B$$

$$r_A = -0.0344\ \frac{\text{ppm}}{\text{min}} \doteq -0.0344\ \frac{\text{mg}}{1\ \text{min}}\ \text{at}\ C_A = 1\ \text{ppm}$$

$$F_B = (25000\ \text{gal})\ (0.0344\ \frac{\text{mg}}{1\ \text{min}})\ \frac{60\ \text{min}}{\text{hr}}\ \frac{1\ \text{g}}{1000\ \text{mg}}\ (\frac{3.7851}{453.6})\ \frac{1}{\text{gal}} = 0.429\ \frac{\text{lbm}}{\text{hr}}$$