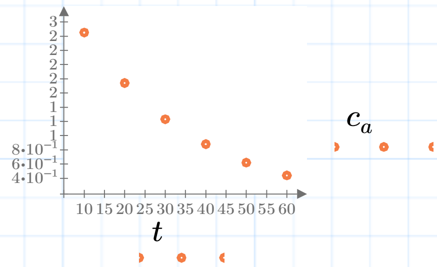
P5-9b

In order to study the Photochemical decay of aqueous bromine in bright sunlight, a small quantity of liquid bromine was dissolved in water contained in a glass battery jar and placed in direct sunlight. The following data was obtained at 25°C

$$t := \begin{bmatrix} 10 \\ 20 \\ 30 \\ 40 \\ 50 \\ 60 \end{bmatrix} \text{ (hr)} \qquad c_a := \begin{bmatrix} 2.45 \\ 1.74 \\ 1.23 \\ 0.88 \\ 0.62 \\ 0.44 \end{bmatrix} \text{ mol/m^3}$$

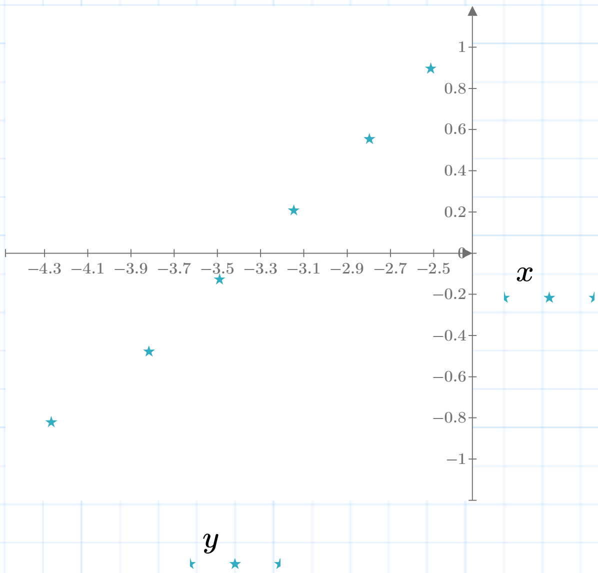
$$h := t_1 - t_0 \qquad n := \text{last}(t)$$



$$deriv := \left\| \begin{array}{l} d_0 \leftarrow \dfrac{-3 \cdot c_{a_0} + 4 \cdot c_{a_1} - c_{a_2}}{2 \cdot h} \\ \text{for } i \in 1 .. n-1 \\ \quad \left\| d_i \leftarrow \dfrac{c_{a_{i+1}} - c_{a_{i-1}}}{2 \cdot h} \right. \\ d_n \leftarrow \dfrac{c_{a_{n-2}} - 4 \cdot c_{a_{n-1}} + 3 \cdot c_{a_n}}{2 \cdot h} \\ d \end{array} \right.$$

$$deriv = \begin{bmatrix} -0.081 \\ -0.061 \\ -0.043 \\ -0.031 \\ -0.022 \\ -0.014 \end{bmatrix}$$

$x := \ln(c_a)$ $\qquad$ $y := \ln(-deriv)$



$m := \text{slope}(x, y)$ $\qquad$ $b := \text{intercept}(x, y)$

$order := m$ $\qquad$ $k := \exp(b)$

$order = 1.014$ $\qquad$ $k = 0.034$

b) Assuming identical exposure conditions, calculate the required hourly rate of injection of bromine (in pounds) into a sunlit body of water, 25000 gal. in volume, in order to mantain a sterilizing level of bromine of 1.0ppm.

$k := 0.034$ $\qquad$ $\gamma := 1$ $\qquad$ $C_a := 1$

$r_a := k \cdot C_a^{\gamma}$

$r_a = 0.034$

$$\frac{d}{dt} N_a = r_{aV} = F_a$$

$$F_a := \frac{2500 \cdot 0.034 \cdot 60 \cdot 3.7851}{1000 \cdot 453.6}$$

$F_a = 0.043$ lbs/hr

c) What experimental conditions would you suggest if you were to obtain more data?

I would suggest calculating the exact conversion that takes place in a volume of 25,000 gal with a molar flow of 0.043 lbs/hr.