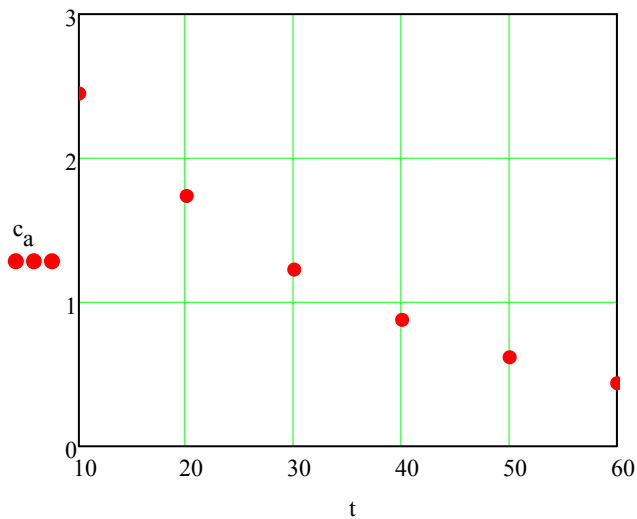


P5-9b

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

$$t := \begin{pmatrix} 10 \\ 20 \\ 30 \\ 40 \\ 50 \\ 60 \end{pmatrix} \quad (\text{hr}) \quad c_a := \begin{pmatrix} 2.45 \\ 1.74 \\ 1.23 \\ 0.88 \\ 0.62 \\ 0.44 \end{pmatrix} \quad \left(\frac{\text{mol}}{\text{m}^3} \right)$$



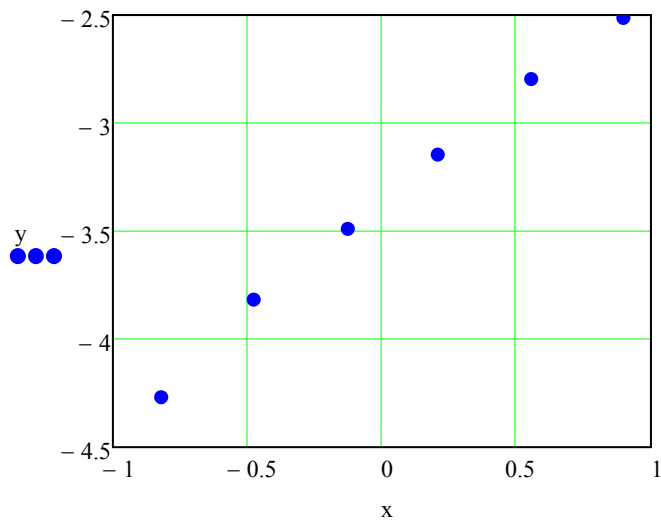
$$h := t_1 - t_0 \quad n := \text{last}(t)$$

$$\text{deriv} := \begin{cases} d_0 \leftarrow \frac{-3 \cdot c_{a0} + 4 \cdot c_{a1} - c_{a2}}{2 \cdot h} \\ \text{for } i \in 1..n-1 \\ d_i \leftarrow \frac{c_{a_{i+1}} - c_{a_{i-1}}}{2 \cdot h} \\ d_n \leftarrow \frac{c_{a_{n-2}} - 4 \cdot c_{a_{n-1}} + 3 \cdot c_{a_n}}{2 \cdot h} \\ d \end{cases}$$

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

$$x := \ln(c_a)$$

$$y := \ln(-\text{deriv})$$



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

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

$$\text{order} := m$$

$$k := \exp(b)$$

$$\text{order} = 1.014$$

$$k = 0.034$$

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 maintain a sterilizing level of bromine of 1.0ppm.

$$k = 0.034$$

$$\gamma := 1$$

$$C_a := 1$$

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

$$r_a = 0.034$$

$$\frac{d}{dt} N_a = r_a V = F_a$$

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

$$F_a := 0.043 \quad \left(\frac{\text{lbs}}{\text{hr}} \right)$$

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.