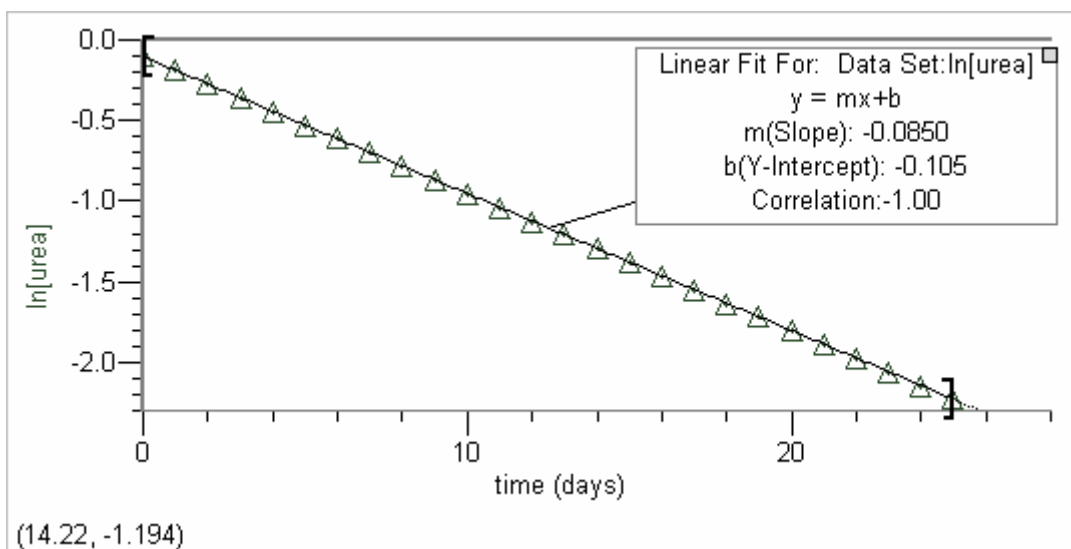


Kinetic of the Hydrolysis of Urea – Part II

Open the file “Hydrolysis of Urea” which shows a plot of [urea] as a function of time. Determine the rate law for this reaction by linearizing the data. You may do this by creating a new calculated column or by copying and pasting the data into Excel. To view the data, select Insert: Table from the main menu.

A graph of $\ln[\text{urea}]$ as a function of time is linear; thus, the reaction is first-order.



What is the reaction's rate constant and rate law?

The rate constant is the negative slope of the first-order plot; thus, k is 0.0850 d^{-1} . The rate law, therefore, is

$$R = k[\text{urea}]$$

What is the original concentration of urea?

Although we have an experimental [urea] at $t = 0$, we also can calculate it using the linearized rate law, which is equivalent to $\ln[\text{urea}]_o$; thus

$$\ln[\text{urea}]_o = -0.105 \quad [\text{urea}]_o = 0.900 \text{ M}$$

What is the reaction's half-life?

For a first-order process, the half-life is

$$t_{1/2} = \frac{0.693}{k} = \frac{0.693}{0.0850 \text{ d}^{-1}} = 8.15 \text{ d}$$

What is the expected rate of the reaction at $t = 10$ days?

To find this we can use the tangent tool to determine the slope at $t = 10$ days. This gives a result of 0.034 M/d . We also can calculate the rate by determining the concentration of urea at $t = 10$ days using the integrated form of the rate law and then substituting into the rate law; thus

$$\ln[\text{urea}]_{t=10} = \ln[\text{urea}]_o - kt$$

$$\ln[\text{urea}]_{t=10} = \ln(0.900) - (0.0850 \text{ d}^{-1}) \times (10 \text{ d})$$

$$\ln[\text{urea}]_{t=10} = -0.955$$

$$[\text{urea}]_{t=0} = 0.385 \text{ M}$$

$$\text{Rate} = k[\text{urea}]$$

$$\text{Rate} = (0.0850 \text{ d}^{-1}) \times (0.385 \text{ M}) = 0.033 \text{ M/d}$$

How many days will it take for the [urea] to reach 0.050 M ?

We can calculate this using the integrated rate law as well; thus

$$\ln[\text{urea}]_t = \ln[\text{urea}]_o - kt$$

$$\ln(0.050) = \ln(0.900) - (0.0850 \text{ d}^{-1}) \times t$$

$$t = 34.0 \text{ d}$$

If the original concentration of urea is 5.0 M , how long will it take for the concentration to reach 0.10 M ?

Changing the initial concentration has no affect on the rate law, which remains the same; thus

$$\ln[\text{urea}]_t = \ln[\text{urea}]_o - kt$$

$$\ln(0.10) = \ln(5.0) - (0.0850 \text{ d}^{-1}) \times t$$

$$t = 46.0 \text{ d}$$