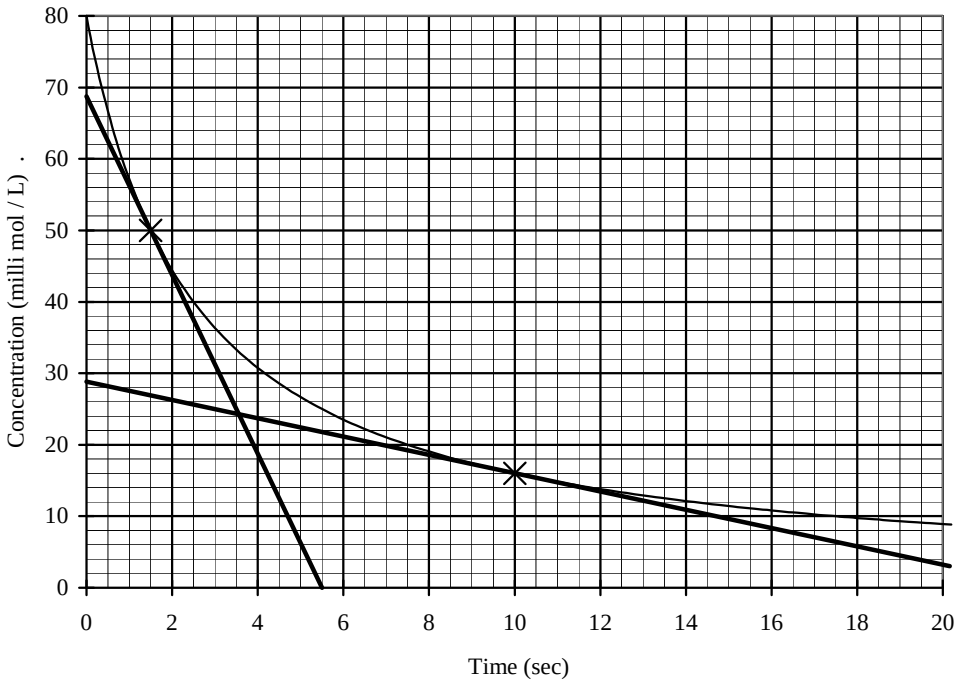
ChemE 2200 - Physical Chemistry II for Engineers

Quiz 9 - March 26, 2025

Name: *Solution*

Draw lines tangent to the curve at 1.5 sec and 10 sec, as shown in the plot below.

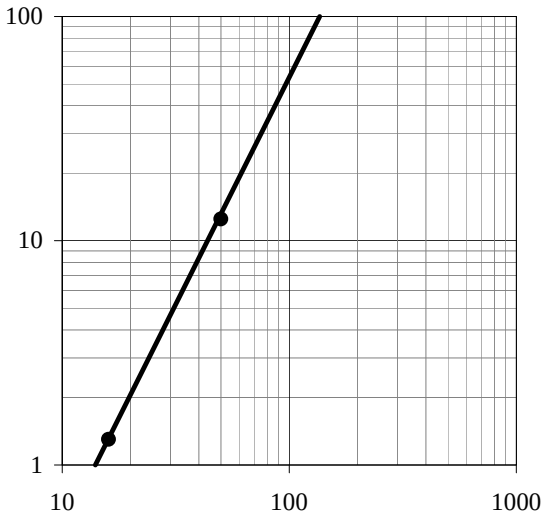


Use the endpoints to calculate the slopes. The tangent line at t = 1.5 sec runs from (0, 69) to (5.5, 0). The slope of the first tangent line is rise/run = (0 – 69)/(5.5 – 0) = 12.5 millimol/(L·sec). The tangent line at t = 10 sec runs from (0, 29) to (20, 3). The slope of the second tangent line is rise/run = (3 – 29)/(20 – 0) = 1.3 millimol/(L·sec).

Add these numbers to the table and add an additional column; the concentration of A.

Time (sec)	$-d$[A]/dt	[A]
1.5	12.5 millimol/(L·sec)	0.050 mol/L
10.0	1.3 millimol/(L·sec)	0.016 mol/L

To determine the reaction order, plot $\log_{10}(-d[A]/dt)$ vs $\log_{10}([A])$. The slope of the line is the reaction order. Plot the points on log-log paper and draw a line through the points, as shown below.



Calculate the slope from the endpoints. The line runs from (0.014, 1.0) to (0.14, 100). The slope is rise/run = ($\log_{10}(100) - \log_{10}(1)$)/($\log_{10}(0.14) - \log_{10}(0.014)$) = 2/1 = 2. Or just estimate the slope; the line rises two decades and runs one decade so the slope is 2.

The reaction is second order.

Grading Rubric:

One point for each of the following ten items:

- drew a tangent line at 1.5 seconds
- drew a tangent line at 10.0 seconds
- used the slope to calculate the reaction rate at 1.5 seconds
- used the slope to calculate the reaction rate at 10.0 seconds
- read concentration of *A* at 1.5 seconds from graph
- read concentration of *A* at 10.0 seconds from graph
- constructed a log-log plot of concentration versus rate
- calculated the log-log slope
- used the equation $\log_{10}\left(-\frac{d[\mathrm{A}]}{dt}\right) = n\log_{10}[\mathrm{A}] + \log_{10} k$ to set slope equal to *n*.
- determined the reaction is second order, $n = 2$.