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## Kinetics of a First-Order Reaction Worksheet

Perform calculations on a separate sheet of paper.

| Volume Added<br>0.1 M NaOH (mL) | Time (sec) | V <sub>total</sub> | $V_{inf} - V_{total}$ | [(CH <sub>3</sub> ) <sub>3</sub> CCl] <sub>t</sub> | ln[(CH <sub>3</sub> ) <sub>3</sub> CCl] <sub>t</sub> |
|---------------------------------|------------|--------------------|-----------------------|--|--|
| 1.0                             |            | 1.0                |                       |  |  |
| 1.0                             |            | 2.0                |                       |  |  |
| 1.0                             |            | 3.0                |                       |  |  |
| 1.0                             |            | 4.0                |                       |  |  |
| 1.0                             |            | 5.0                |                       |  |  |
| 1.0                             |            | 6.0                |                       |  |  |
| 1.0                             |            | 7.0                |                       |  |  |
| 1.0                             |            | 8.0                |                       |  |  |
| 1.0                             |            | 9.0                |                       |  |  |
| 1.0                             |            | 10.0               |                       |  |  |
|                                 | $\infty$   |                    |                       |  |  |

rate constant, k \_\_\_\_\_\_ sec<sup>-1</sup>

[(CH<sub>3</sub>)<sub>3</sub>CCl]<sub>0</sub> \_\_\_\_\_moles/L

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## Calculations

1. The concentration of *tert*-butyl chloride at each time a color change occurs can be calculated from the values of total volume of sodium hydroxide added at each time,  $Vol_{total}$  and the total volume of sodium hydroxide added at time =  $\infty$ ,  $Vol_{inf}$ .

$$[(CH_3)_3CCI]_t = (Vol_{inf} - Vol_{total}) \times (0.1 \text{ M})/4400 \text{ mL solution}$$
Equation 11

a. Calculate (Vol<sub>inf</sub> - Vol<sub>total</sub>) for each time recorded. Enter these values in the Data Table.

*b.* Calculate  $[(CH_3)_3CCI]_t$  for each time recorded. Enter these values in the Data Table. Enter  $[(CH_3)_3CCI]_0$  on the line below the Data Table.

*c*.Calculate ln[(CH<sub>3</sub>)<sub>3</sub>CCl]<sub>t</sub> for each time recorded. Enter these values in the Data Table.

- 2. Have students plot  $\ln[(CH_3)_3CCI]_t$  versus time, in seconds, on their graph paper. From the graph, have students determine the rate constant *k* (– slope). Enter this value on the line below the Data Table. Did the reaction follow first-order kinetics?
- 3. The half-life of a reaction  $(t_{1/2})$  is the time it takes for one-half the reactants to be consumed.

For a first-order reaction

$$t_{1/2} = \frac{0.693}{k} \qquad \qquad Equation \ 12$$

Calculate the half-life for the reaction.

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In[(CH<sub>3</sub>)<sub>3</sub>CCI]