

S_N1 Reaction: Hydrolysis of *tert*-butyl chloride

Description: The hydrolysis of *tert*-butyl chloride in acetone and water undergoes drastic color changes in the presence of base and universal indicator.

Materials:

5% *t*-butyl chloride in acetone

Deionized water

0.1 M NaOH

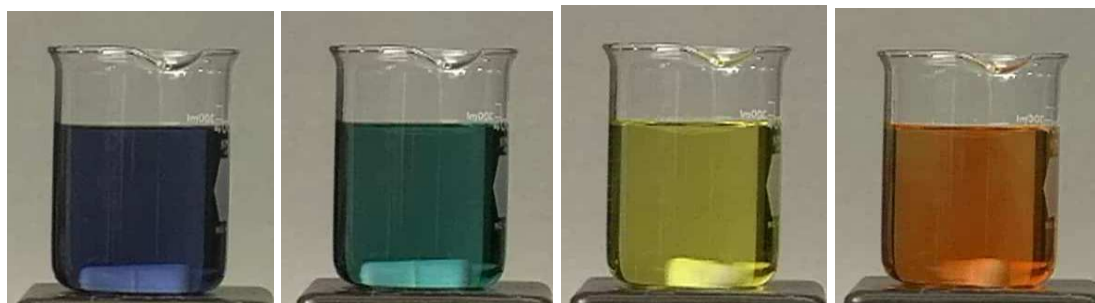
Beaker, stir bar, stir plate

Universal Indicator

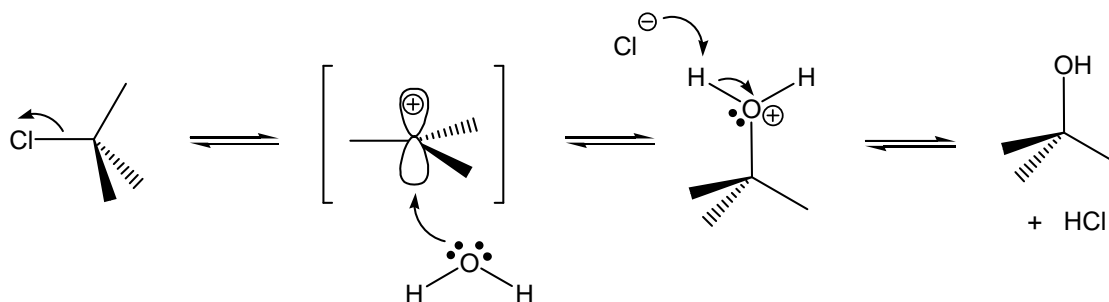
Stopwatch (for kinetics)

Procedure:

1. Add 15 mL of 0.1 M NaOH to 200 mL of deionized water and add 5 drops of universal indicator. Stir this solution.
2. Add 10 mL of 5% *t*-butyl chloride solution all at once. The color will change quickly (within one minute) from blue to green to yellow to orange and finally red. Qualitative kinetics measurements can be performed by measuring the length of time required to obtain a red color. The concentration of *t*-butyl chloride can be changed to observe the change in rate with change in [*t*BuCl].



Discussion: This experiment demonstrates a typical S_N1 reaction (shown below) between water and *tert*-butyl chloride. In this demonstration the initial solution is alkaline as determined by the color of the indicator in solution. As the hydrolysis occurs, HCl is generated as one of the products, thus lowering the pH of the solution which is indicated by the observed color changes. Since this reaction goes through an S_N1 mechanism, the rate of the reaction (Rate = $k[t\text{BuCl}]$) is only affected by a change in the concentration of the alkyl halide substrate, not the incoming nucleophile.



Safety: Wear proper protective equipment including gloves and safety glasses when preparing and performing this demonstration. Concentrated solutions of acids and bases (>2 M) can irritate the skin and cause burns.

Disposal: The solution should be neutralized with dilute acetic acid and disposed of in an aqueous waste container.

References:

Herbrandson, H. F. *J. Chem. Educ.* **1971**, *48*, 706.

Newton, T. A.; Hill, B. A. *J. Chem. Educ.* **2004**, *81*, 58. (S_N1 using conductivity apparatus)

Newton, T. A.; Hill, B. A. *J. Chem. Educ.* **2004**, *81*, 61. (S_N2 using conductivity apparatus)

Video:

<http://www.youtube.com/watch?v=y6SSTMBqMXs>

http://www.uni-regensburg.de/Fakultaeten/nat_Fak_IV/Organische_Chemie/Didaktik/Keusch/D-tertbu-e.htm