

Organic Chemistry 211 Laboratory **Nucleophilic Substitution of Alkyl Halides**

(Part 1: Structural Effects on the S_N1 and S_N2 Reactivities)

Waste Disposal: All the reaction mixtures should be placed in the halogenated organic waste container.

Objective: To study the reactivities of different alkyl halides under 2 sets of nucleophile and solvent conditions, favoring S_N1 and S_N2 mechanisms.

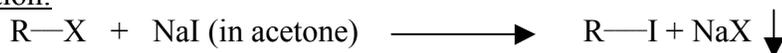
Experiment Overview: A series of relative rates and reactivities will be studied under S_N1 and S_N2 conditions, with 5 different substrates and 2 different solvent-nucleophile systems. If the reactions occur, the general equation for these reactions will be as follows:

For S_N2

Nucleophile: NaI (essentially I⁻)

Solvent: acetone (slightly polar, aprotic)

General Equation:



The resulting sodium halide is insoluble in acetone.

For S_N1

Nucleophile: NO₃⁻

Solvent: ethanol (polar, protic)

General Equation:



The resulting silver halide is insoluble in ethanol.

Procedure:

Label 5 clean and thoroughly dry test tubes with numerals 1 to 5. In each test tube place 0.2 mL of the following alkyl halides: (1) n-butyl chloride, (2) n-butyl bromide, (3) *sec*-butyl chloride, (4) *tert*-butyl chloride, and (5) crotyl chloride {CH₃CH=CHCH₂Cl}. Keep the tubes corked at all times before and after adding the reagents. Obtain 11.0 mL of 15% NaI-acetone solution and 11.0 mL of ethanolic silver nitrate solution in two capped containers, for the S_N2 and S_N1 conditions, respectively.

For each reaction mechanism, and with each solvent-nucleophile mixture, with the test tubes arranged numerically, start the reaction by adding 2.0 mL of the solvent-nucleophile mixture (one test tube at a time), and considering the following pointers:

- There will be a total of 10 reactions (5 with each solvent-nucleophile mixture).
- Add in one shot, not dropwise.
- Upon each addition, record the time.
- Upon each addition, mix the reactants completely.
- Measure the time it takes for each reaction to come to completion. This is possible via visual detection of the precipitate, forming in the test tube.

For your report:

Discuss the preferences of the different substrates to react one way or the other. Use your collected time data as support for your discussion.

Needed per student:

n-butyl chloride (4 mL) -----→ 60 mL per lab
n-butyl bromide(4 mL) -----→ 60 mL per lab
sec-butyl chloride(4 mL) -----→ 60 mL per lab
tert-butyl chloride(4 mL) -----→ 60 mL per lab
crotyl chloride(4 mL) -----→ 60 mL per lab
15% NaI in acetone (11.0 mL)-----→ 165 mL per laboratory
1% AgNO₃ in ethanol (11.0 mL)-----→ 165 mL per laboratory