**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:**

\[
R\text{---}X + \text{NaI (in acetone)} \rightarrow R\text{---}I + \text{NaX}
\]

The resulting sodium halide is insoluble in acetone.

For $S_N1$

Nucleophile: NO$_3^-$  
Solvent: ethanol (polar, protic) 
**General Equation:**

\[
R\text{---}X \rightarrow R^+ + X^- + \text{AgNO}_3 \rightarrow \text{NO}_3^- + \text{AgX}
\]

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 {CH$_3$CH=CHCH$_2$Cl}. 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
*butyl chloride(4 mL) ----------------------→ 60 mL per lab
*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