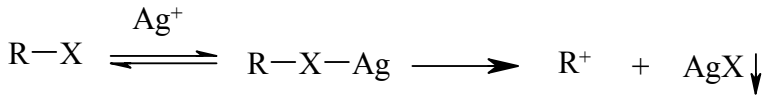
Substitution Reactions of Alkyl Halides

Purpose: To examine the relative rates of various alkyl halides under Sn1 and Sn2 conditions.

We will be examining Sn2 reactions with the Finkelstein reaction. The conditions for this are NaI in acetone. NaI is soluble in acetone but the products of the reaction; NaCl and NaBr are not. We will watch the reaction by looking for the first appearance of the solid salts. Acetone is a good solvent for Sn2 reactions because it is a polar aprotic solvent.

We will be examining Sn2 reactions with an ethanolic solution of silver nitrate. The silver ion coordinates with a lone pair on the halogen which begins to weaken the carbon-halogen bond. In the rate determining step, the carbocation and solid silver halide is formed. We will monitor the reaction by looking for the formation of the solid.



Procedure:

Sn2
Assemble and label six clean, dry test tubes. To follow the rates, it will be easier to react only four test tubes at a time. To each add a different alkyl halide (0.1 mL). To each test tube add 1 mL of a 1 M solution of NaI in acetone and mix thoroughly. For each tube, note how long after the addition of the NaI solution the first trace of precipitate appears. Watch the tubes to a maximum time of 6 minutes after the addition. If no reaction occurs, place the tubes in a 50° water bath and record the time to reaction at the higher temperature. (Record the temperature of the bath.) Use Aluminum foil to cover the test tubes to discourage acetone from evaporating.

Sn1
Assemble and label six clean, dry test tubes. To each add a different alkyl halide (0.1 mL). (Again, to follow the rates, it may be easier to react only four test tubes at a time.) To each test tube add 1 mL of a 0.1 M solution of $AgNO_3$ in ethanol and mix thoroughly. (Avoid skin contact! Silver salts + skin -> long-lived brown stain). For each tube, note how long after the addition of the $AgNO_3$ solution the first trace of precipitate appears. Watch the tubes to a maximum time of 6 minutes after the addition. If no reaction occurs, place the tubes in a 50° water bath and record the time to reaction at the higher temperature. Dispose of the used samples in the special container labeled "Silver Residues". Cover the tubes with aluminum foil. Be careful not to allow the ethanol to evaporate.

Before lab:
Prepare your notebook to take data. You should create some kind of table to take data. Leave plenty of room to write in the structures of the halides.

Halide (Structure)	**Time at 25 °**	**Time at 50 °**	**Observations**

In your discussion, address the following questions:

Discussion

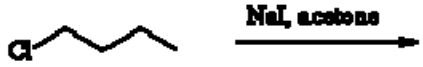
1)
   a) Which alkyl chloride reacted fastest with sodium iodide in acetone: 1-chlorobutane, 2-chlorobutane or 2-chloro-2-methylpropane?
   b) Which alkyl chloride reacted slowest?
   c) Explain how the structure of the alkyl halide affects the rate of an SN2 reaction.
   d) Why doesn't bromobenzene react?

2)
   a) Which halide reacted faster with sodium iodide in acetone: 1-bromobutane or 1-chlorobutane?
   b) Explain how the nature of the leaving group affects the rate of an SN2 reaction.
   c) Would 1-iodobutane react faster or slower than the other halides? Explain.

3)
   a) Which alkyl chloride reacted fastest with silver nitrate in ethanol: 1-chlorobutane, 2-chlorobutane or 2-chloro-2-methylpropane?
   b) Which alkyl chloride reacted slowest?
   c) Explain how the structure of the alkyl halide affects the rate of an SN1 reaction.
   d) Would you expect that the 1-chloro-2-butene would be faster than 1-chlorobutane and why?

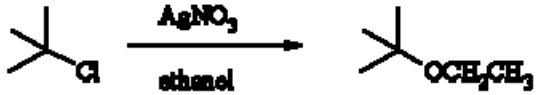
Post Lab Questions:

1. **a Please draw the mechanism for the following reaction:**

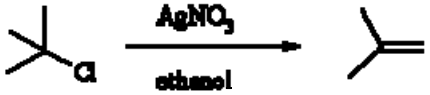


   b. What would be the effect on the rate if we doubled the NaI concentration?

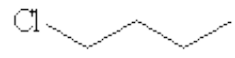
2. **Please draw the mechanism for the following reaction:**

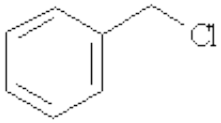


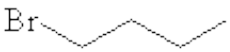
3. **Please draw the mechanism for the following reaction:**

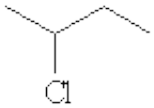


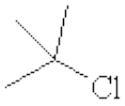
Here are the compounds that we will look at in the Substitution lab this year.

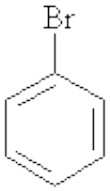












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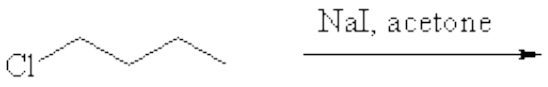

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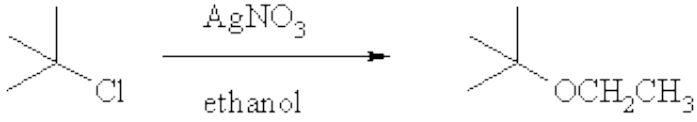
2. Please draw the mechanism for the following reaction:



3. Please draw the mechanism for the following reaction: