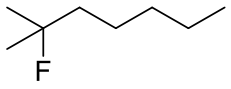
Start-up/Learning Outcomes (LO): Nucleophilic Substitution

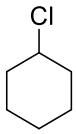
Essential Skills

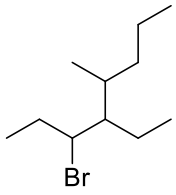
1. Label carbon atoms as sp, sp^2, or sp^3 hybridized.
2. Determine the IUPAC name for alkyl halides.
3. Identify nucleophiles and electrophiles. Also, draw arrows for the flow of electrons from nucleophile to electrophile.

Problems

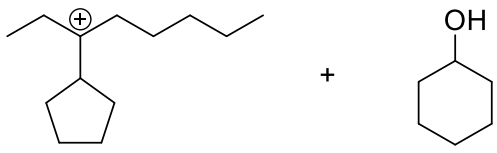
1. Provide the IUPAC name for each of the following.

a. 

b. 

c. 

2. For each pair, identify the nucleophile and electrophile. Then provide arrows to show the flow of electrons from the nucleophile to the electrophile. Clearly draw in any lone pairs needed.

a. 

b. 

Learning Outcomes (LO)

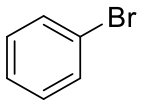
1. Label primary (1°), secondary (2°), and tertiary (3°) alkyl halides.
2. Compare leaving groups (LG) and rank them. (Also relate to basicity).
3. Identify vinyl halide, aryl halide, allylic halide, and benzylic halides.
4. Explain why vinyl and aryl halides do not undergo S_N1 and S_N2 reactions.
5. Predict products and show mechanisms of nucleophilic substitution reactions, including stereochemistry when necessary.
6. Determine if a given nucleophilic substitution proceeds predominantly by an S_N1 or S_N2 mechanism and explain how you know.
7. Provide electron-pushing mechanism and/or energy diagram for S_N1 and S_N2 reactions.
8. Understand **why** S_N1 reactions follow first order reaction kinetics while S_N2 reactions follow a second order reaction rate.
9. If given two reactions, predict which one will be faster by considering concentrations, leaving groups, steric effects, solvent effects, temperature, nucleophile strength (for S_N2 reactions) and carbocation stability (for S_N1 reactions.)
10. Explain the Hammond Postulate.

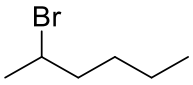
Problems

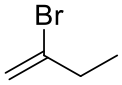
1. For the structures in problem 1 of essential skills, state whether the alkyl halide is 1°, 2°, or 3°.

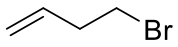
2. Circle the molecule(s) that are expected to be reactive in a substitution reaction.

- Is there a leaving group?
- Is the leaving group bonded to an sp^3 hybridized carbon?





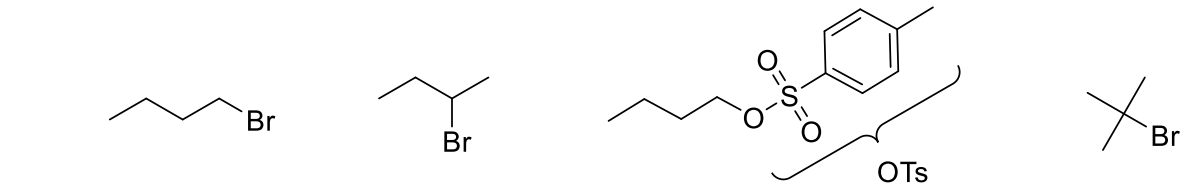





For the molecules that you did not circle, explain why they are unreactive in a substitution reaction (drawing orbitals may be helpful here).

3. For the following reactions, identify the nucleophile, electrophile, and solvent. What type of substitution reaction do you expect to occur, S_N2 or S_N1? Last, draw an arrow-pushing mechanism to predict the product of the reaction, including stereochemistry. Remember to draw lone pairs of electrons needed and electrons flow from nucleophile to electrophile.

4. Rank the following in order of leaving group ability in an S_N2 and S_N1 reaction (1 = best, 4 = worst). Place the numbers in the box provided.



S_N2	☐	☐	☐	☐
S_N1	☐	☐	☐	☐