Organic Chemistry – Exercise 6

Distribution: November 6, 2025

Help: November 13, 2025

Return until: November 15, 2025

1. Acetic acid is an organic acid responsible for the taste and the smell of the vinegar. It is used in food production as a preservative and flavoring, as a cleaning agent and as a reactant or catalyst in production of chemicals, plastic materials and pharmaceuticals. It is industrially synthesized from methanol via Monsanto process. The first step of this process is the reaction of methanol with hydrogen iodide.
    a. Write the equation of the reaction between methanol and hydrogen iodide. Give the name of the main product.

    b. Show the detailed mechanism of this reaction! Precisely, what type of reaction is this? Explain your answer.

    c. What is the role of hydrogen iodide in this reaction? Could potassium iodide be used instead?

    d. Does an increase in the concentration of hydrogen iodide affect the rate of this reaction? Explain your answer.

2. The Lucas test is a qualitative test for alcohols. It is used to differentiate between primary, secondary and tertiary alcohols. The Lucas reagent is a solution of zinc chloride in concentrated hydrochloric acid.

    a. What type of reaction happens between alcohols and Lucas reagent?

    Primary, secondary, and tertiary alcohols react differently with the Lucas reagent. Tertiary alcohols react immediately with the reagent at room temperature and the resulting halide is observed as a phase not miscible with aqueous phase. Secondary alcohols react after a few minutes of heating the reaction mixture, while primary alcohols practically do not react with this reagent. However, the test is usually used only for detection of tertiary alcohols.

    b. Show the mechanism of the reaction that happens when *tert*-butanol (2-methylpropan-2-ol) reacts with the Lucas reagent. What is the name of this mechanistic pathway (be precise!)?

    c. Based on the mechanism of the reaction, explain in detail the difference in reactivity between primary, secondary and tertiary alcohols.

3. Phenylacetic acid is a catabolite of phenylalanine, one of the essential amino acids. Phenylacetic acid can be synthesized through a two-step process, where the first step is the reaction of substituted benzyl halide and cyanide ion, and the second step is hydrolysis of the formed nitrile.

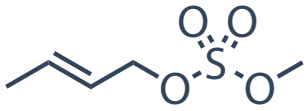
    a. Write the equation (using structural formulae) for the reaction of benzyl chloride with sodium cyanide.

    b. Name the mechanism of this reaction (precisely)? Show its mechanism.

    c. Comment on whether the mechanism of the reaction would differ if *p*-methoxybenzyl chloride was used in this reaction. Would this reaction be faster or slower than the one in a)? Explain your answers by showing the mechanism and resonance structures of the intermediate (if one is formed).

    d. Comment whether the mechanism of the reaction would differ if *p*-nitrobenzyl chloride was used in this reaction. Explain your answers by showing the mechanism and resonance structures of the intermediate (if one is formed).

4. Consider the following compound.



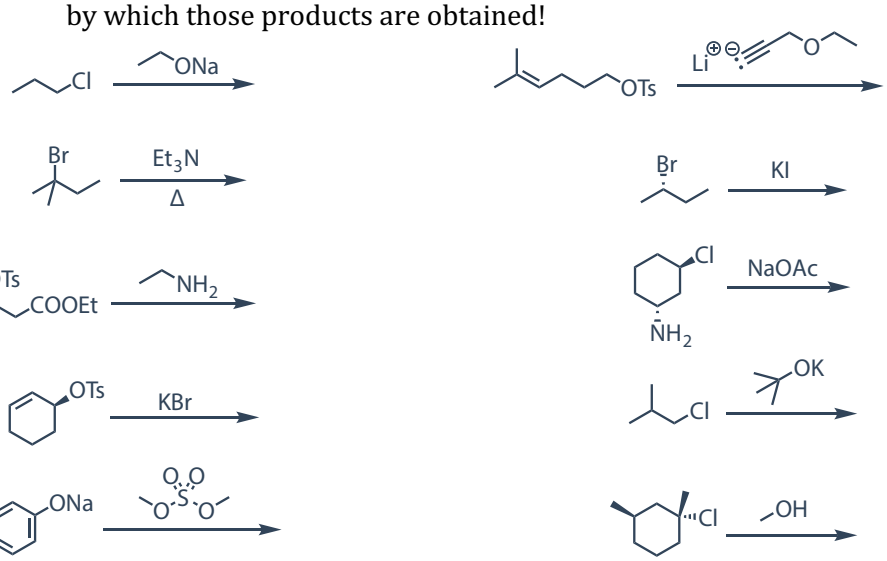
It can react with ethanol in a monomolecular nucleophilic substitution reaction to give **two different products**.

a. Show the formation of the intermediate. Show the resonance structures of this intermediate and comment on its stability.

b. Propose the structures of the potential two products after the reaction with ethanol. Are these products chiral and, if they are, are they enantio-pure? Explain your answers.

c. What is the potential side reaction that can occur in this system? Show its mechanism, give the reaction type (precisely) and give the name of the product. How could you favor the main reaction over the side reaction by varying the reaction conditions?

5. Give the structures of the major products formed in the following reactions (include stereochemical details where relevant)! Give the acronyms for the reaction mechanisms by which those products are obtained!



Reading Suggestions:

Clayden, Greeves, Warren, *Oxford University Press*, **2012**.

Organic Chemistry, John McMurry, *Thomson Brooks/Cole*, **2008**.

Chimie Organique, Les Grands Principes, John McMurry, *Dunod Editeur*, **2009**.

Chimie Organique, Paul Arnaud, *Dunod Editeur*, **2009**.