

## Objectives for Chapter 9 – Alkyl Halides I

### I. Introduction to Alkyl Halides

#### Types of Organic Halides

1. Classify compounds as alkyl halides, aryl halides, vinyl halides, acid halides, geminal and vicinal dihalides, benzyl halides, and allyl halides.
2. Explain which types of halides can undergo alkyl halide reactions.
3. Classify alkyl halides as methyl, primary, secondary, or tertiary.

#### Where organic halides are found

4. Explain why halides are not common in nature.
5. Explain why iodine is necessary in the human diet, what happens if we don't get enough, and where it comes from.
6. Give some examples of halides that are used in industrial, commercial, or medical applications.

#### Preparation of alkyl halides

7. Write a reaction for the formation of alkyl halides from alkanes, as well as its mechanism.
8. Identify alkyl halides that can be effectively formed using this reaction, and explain why.

#### Spectroscopy of alkyl halides

9. Give the IR bands typically found in the IR spectra of alkyl halides, and explain why IR is not always a good way to identify them.
10. Give the chemical shifts of H's typically found in the proton NMR of alkyl halides, and analyze spectra, sketch the spectra of compounds, and give compounds when provided with a spectrum.

#### Reactivity of alkyl halides

11. Give the order of reactivity of alkyl halides containing each of the 4 common halides, and explain why.
12. Give the three ways in which alkyl halides react, and explain why they react in these ways.

#### Nomenclature of alkyl halides

13. Explain when common names can be used, and construct common names for alkyl halides which have them, or draw structures when given the names.
14. List the steps for naming an alkyl halide according to the IUPAC systematic rules.

15. Name alkyl halide compounds, or draw structures when provided with names.

## **II. Substitution Reactions of Alkyl Halides**

### Introduction

1. Explain the difference between substitution and elimination reactions, and identify reactions as one of these two.

### Mechanisms

2. Draw the mechanism for an  $S_N2$  and  $S_N1$  reaction.

3. Explain why the compounds can dissociate, or behave as electrophiles, nucleophiles, acids, or bases.

### Which substitution reaction?

4. Explain how  $S_N2$  and  $S_N1$  reactions are similar.

5. Explain how the nucleophiles and electrophiles in the  $S_N2$  and  $S_N1$  reactions are different, and what determines which mechanism will occur.

### Nucleophiles in substitution reactions

6. Identify nucleophiles which can be used in substitution reactions of alkyl halides, and explain why some are better nucleophiles than others.

7. Determine whether a nucleophile is a strong or weak nucleophile.

### Products of substitution reactions

8. When given a nucleophile, identify what product will be formed; when given a product, determine what nucleophile(s) will be needed to form it.

9. List the types of functional groups that can be formed by substitution reactions of alkyl halides.

### Stereochemistry

10. Explain what happens to a stereocenter involved in an  $S_N2$  reaction and an  $S_N1$  reaction, and explain the difference between them.

11. Give the products of both  $S_N2$  and  $S_N1$  reactions, showing correct stereochemistry.

### Rate laws

12. Write the rate laws for  $S_N2$  and  $S_N1$  reactions, and explain why they are different.

13. Explain how the substitution of the alkyl halide (methyl,  $1^\circ$ ,  $2^\circ$ ,  $3^\circ$ ) affects its reaction rate in both

$S_N2$  and  $S_N1$  reactions, and why they are different.

14. Explain how the identity of the halide affects the reaction rates of  $S_N2$  and  $S_N1$  reactions, and why they are the same.

#### Rearrangements

15. Explain which substitution reaction is subject to rearrangements, and why.

16. Predict the products that will be formed by a reaction in which rearrangements occur.

#### Solvents

17. Explain why solvents are important in a reaction.

18. Explain how the polarity and hydrogen bonding ability of a solvent affect the rates of  $S_N2$  and  $S_N1$  reactions, and what kinds of solvents are best to use.

19. Determine whether a solvent would be effective or not for an  $S_N2$  or  $S_N1$  reaction.

#### Exclusion of aryl, vinyl, and acid halides

20. Recognize when substitution reactions will not be effective because they would require aryl, vinyl, or acid halides, and give an explanation of why.

### **III. Synthesis using Substitution Reactions**

1. When given a compound to synthesize, identify what alkyl halide(s) could be used as the starting material, what nucleophile(s) could be used as the reagent, which mechanism will occur, and whether the proposed synthesis will be effective.

2. Write a reaction to effectively synthesize compounds using substitution reactions.