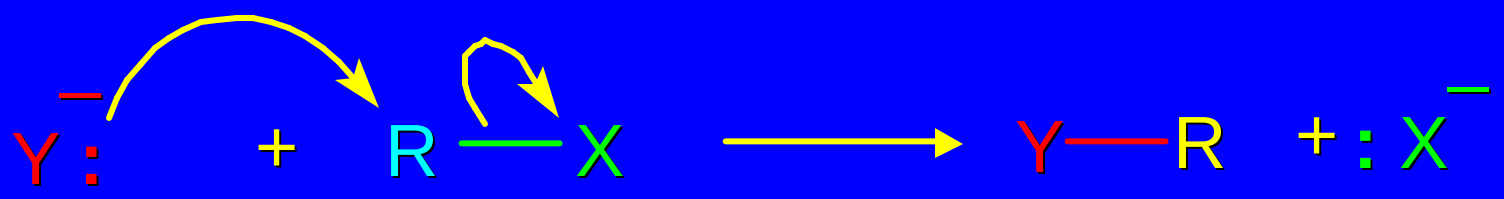
Chapter 8
Nucleophilic Substitution

8.1
Functional Group Transformation By Nucleophilic Substitution

Nucleophilic Substitution



nucleophile is a Lewis base (electron-pair donor)

often negatively charged and used as Na^+ or K^+ salt

substrate is usually an alkyl halide

Nucleophilic Substitution

Substrate cannot be an a vinylic halide or an aryl halide, except under certain conditions to be discussed in Chapter 23.

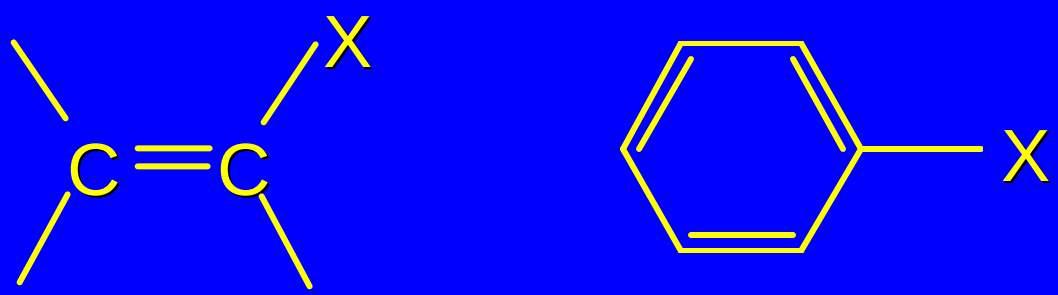
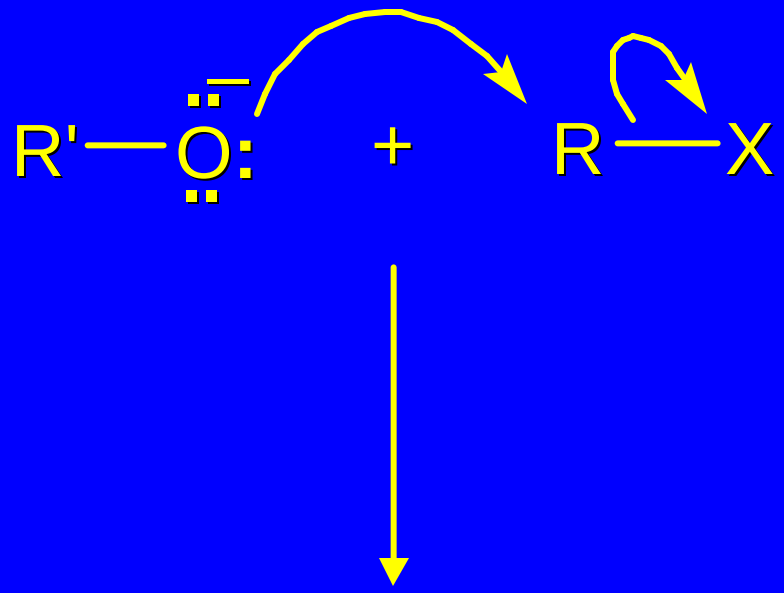


Table 8.1 Examples of Nucleophilic Substitution

Alkoxide ion as the nucleophile



gives an ether

Example

$(CH_3)_2CHCH_2ONa$ + CH_3CH_2Br

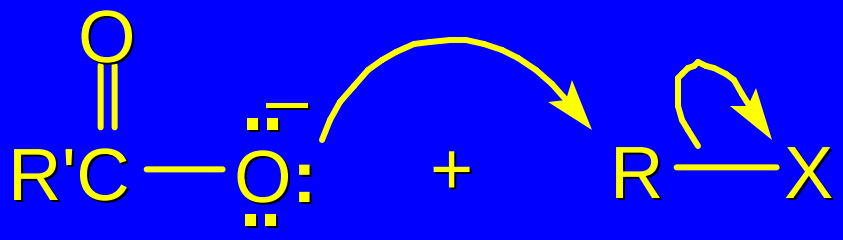
Isobutyl alcohol

$(CH_3)_2CHCH_2OCH_2CH_3$ + NaBr

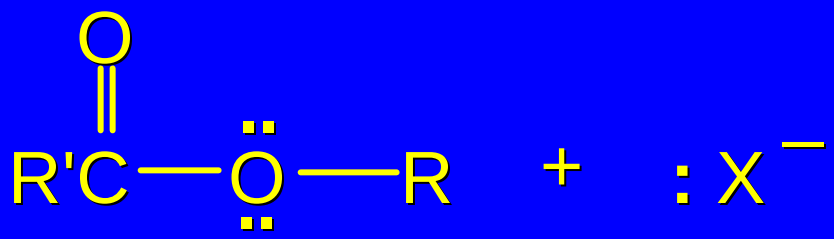
Ethyl isobutyl ether (66%)

Table 8.1 Examples of Nucleophilic Substitution

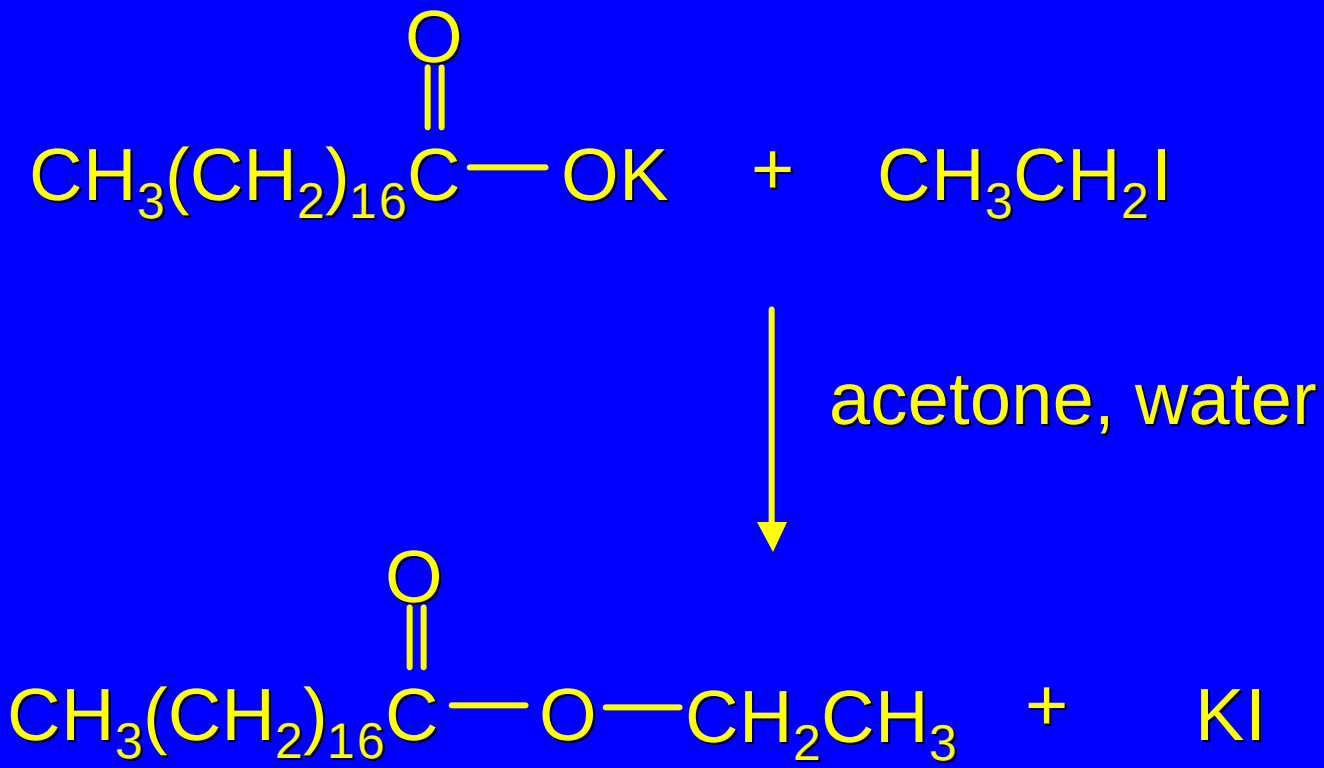
Carboxylate ion as the nucleophile



gives an ester



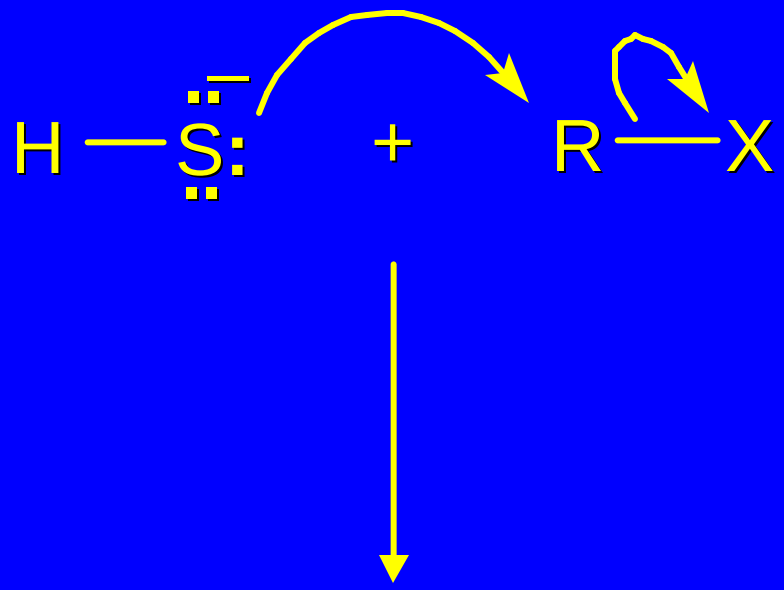
Example



Ethyl octadecanoate (95%)

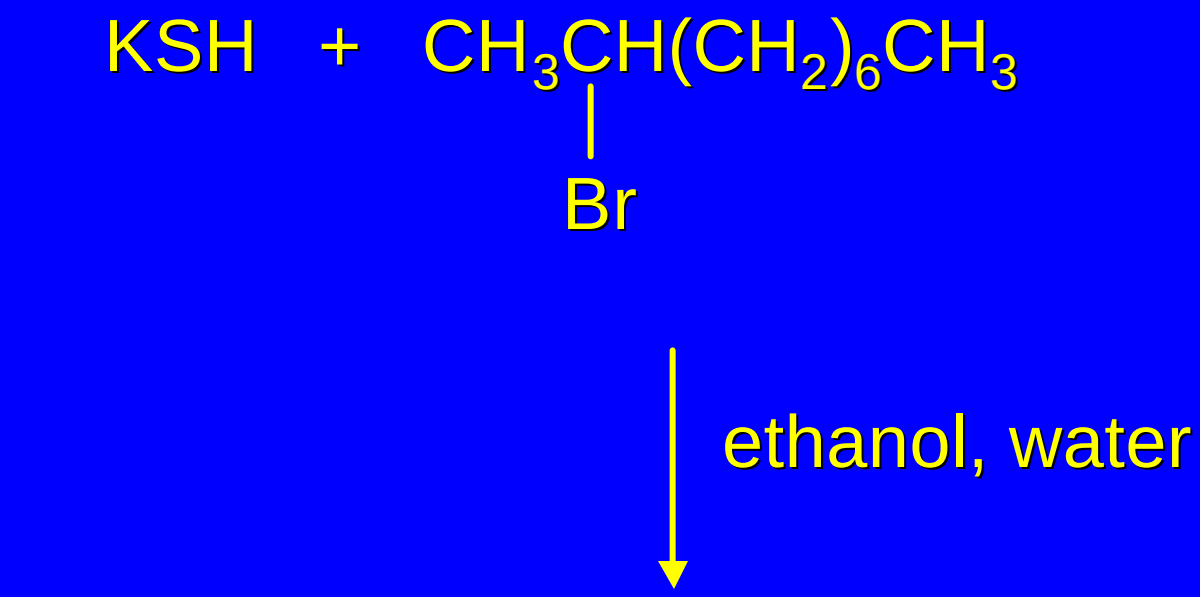
Table 8.1 Examples of Nucleophilic Substitution

Hydrogen sulfide ion as the nucleophile



gives a thiol

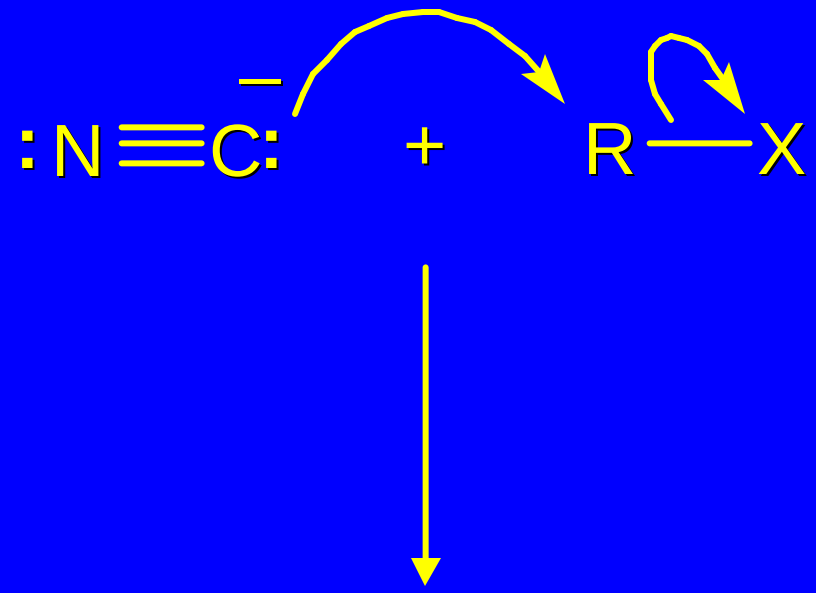
Example



2-Nonanethiol (74%)

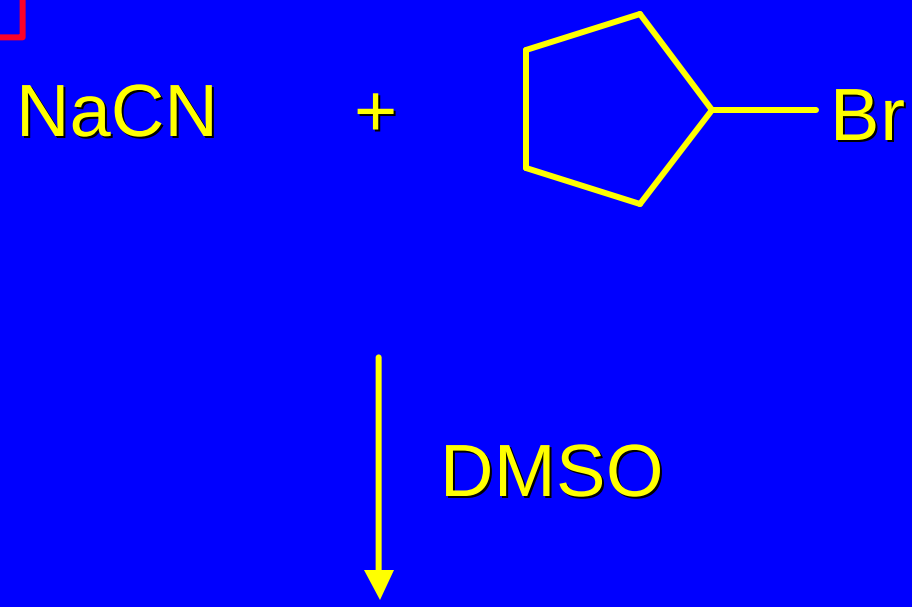
Table 8.1 Examples of Nucleophilic Substitution

Cyanide ion as the nucleophile



gives a nitrile

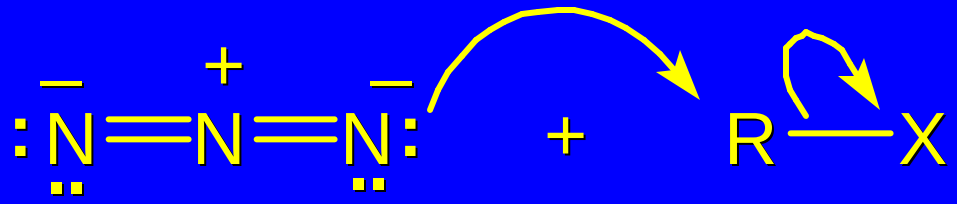
Example



Cyclopentyl cyanide (70%)

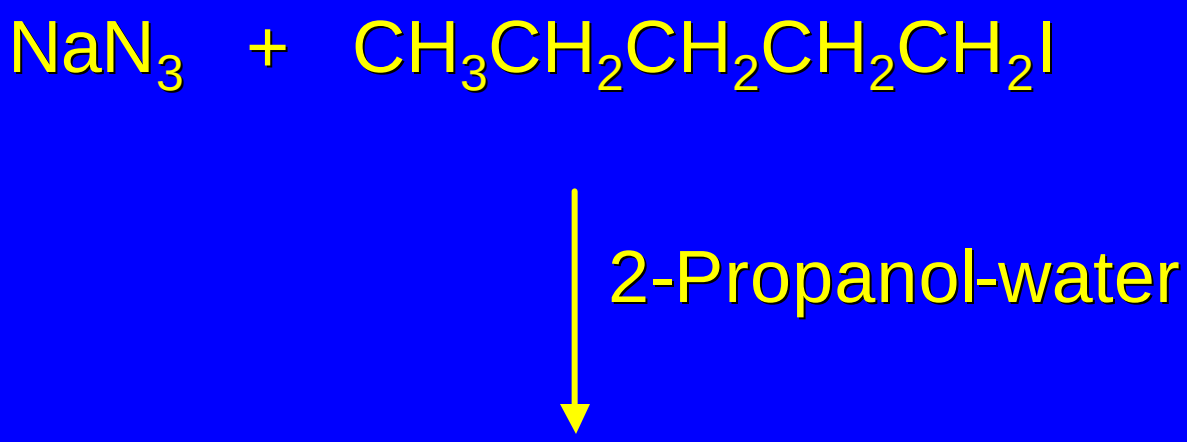
Table 8.1 Examples of Nucleophilic Substitution

Azide ion as the nucleophile



gives an alkyl azide

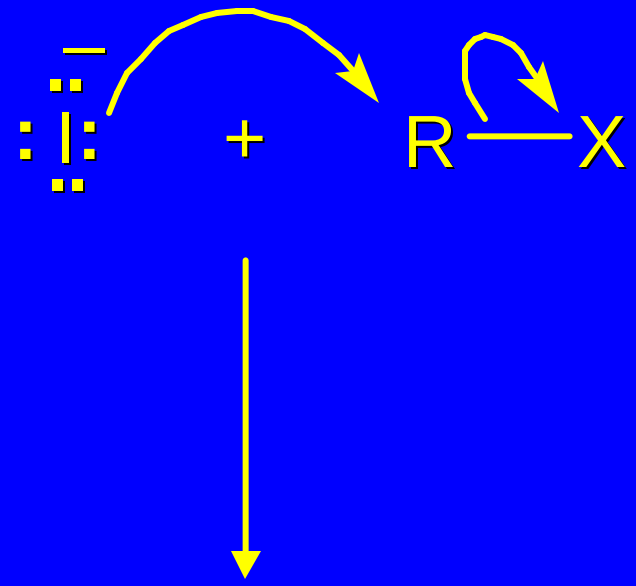
Example



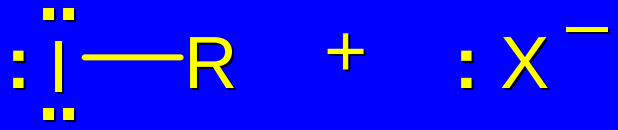
Pentyl azide (52%)

Table 8.1 Examples of Nucleophilic Substitution

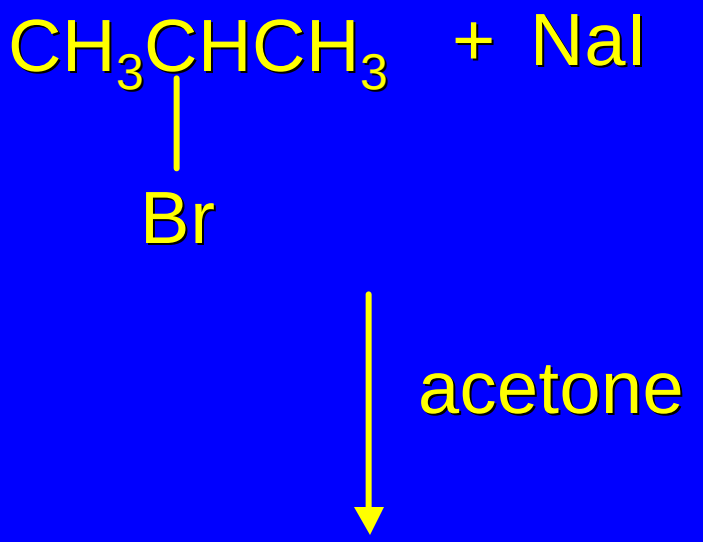
Iodide ion as the nucleophile



gives an alkyl iodide



Example



NaI is soluble in acetone; NaCl and NaBr are not soluble in acetone.

8.2
Relative Reactivity of Halide Leaving Groups

Generalization

Reactivity of halide leaving groups in nucleophilic substitution is the same as for elimination.

RI most reactive

RBr

RCl

RF least reactive

Problem 8.2

A single organic product was obtained when 1-bromo-3-chloropropane was allowed to react with one molar equivalent of sodium cyanide in aqueous ethanol. What was this product?

$$BrCH_2CH_2CH_2Cl + NaCN$$

Br is a better leaving group than Cl

Problem 8.2

A single organic product was obtained when 1-bromo-3-chloropropane was allowed to react with one molar equivalent of sodium cyanide in aqueous ethanol. What was this product?