

Appendix B

CLASSIFICATION OF REACTIONS BY TYPE OF COMPOUND SYNTHESIZED

Acetals and Ketals

- 0-12 Reaction between alkoxides and *gem*-dihalides (Williamson) or α -halo ethers
- 0-15 Reaction between diazoalkanes and alcohols
- 0-17 Transesterification
- 0-79 Reduction of ortho esters
- 0-92 Reaction between Grignard reagents and ortho esters
- 4-7 Electrolytic alkoxylation of ethers
- 4-8 Cyclization of β -hydroxy ethers
- 5-4 Addition of alcohols or phenols to triple bonds
- 6-6 Addition of alcohols to aldehydes or ketones
- 6-53 Addition of aldehydes to olefins (Prins)
- 6-57 Trimerization and polymerization of aldehydes

Acetoxy Sulfides

- 9-71 Pummerer rearrangement

Acetylenes (*see* Alkynes)

Acids (*see* Carboxylic Acids, Sulfonic Acids)

Acyals

- 5-5 Addition of carboxylic acids to alkynes
- 6-56 Acylation of aldehydes or ketones
- 9-14 Bisdecarboxylation of malonic acids
- 9-17 Oxidation of arylmethanes with CrO_3 and Ac_2O

Acyl Halides

- 0-3 Reaction between 1,1,1-trihalides and SO_3
- 0-74 From carboxylic acids
- 0-75 Conversion of acid derivatives to acyl halides
- 4-3 Halogenation of aldehydes
- 5-1 Addition of hydrogen halides to ketenes
- 5-22 Free-radical addition of acyl halides to olefins
- 9-22 Oxidation of alcohols

Acyloxy Ketones

- 5-44 Addition of an acyl and an acyloxy group to a double bond

Acyloins (*see* Hydroxy Aldehydes and Ketones)

Alcohols (*see also* Diols, Hydroxy Esters, etc.)

- 0-1 Hydrolysis of alkyl halides
- 0-4 Hydrolysis of inorganic esters
- 0-6 Hydrolysis of enol ethers, acetals, or ortho esters
- 0-10 Hydrolysis of carboxylic esters
- 0-17 Transesterification
- 0-18 Payne rearrangement
- 0-23 Transesterification
- 0-55 Ammonolysis of carboxylic esters
- 0-68 Cleavage of ethers with concentrated acids
- 0-79 Reduction of acetals or ortho esters
- 0-80 Reduction of epoxides
- 0-92 Cleavage of acetals or ortho esters with Grignard reagents

Alcohols (continued)

- 0-93** Reaction between organometallic compounds and epoxides
0-97 Alkylation of alcohols
0-114 Hydrolysis of sulfonic esters
1-12 Alkylation of aromatic rings with ethylene oxide
1-22 Hydroxyalkylation of aromatic rings
2-25 Reaction between organometallic reagents and oxygen
4-4 Hydroxylation at an aliphatic carbon
4-23 Free-radical hydroxymethylation of aromatic rings
5-2 Hydration of olefins and of cyclopropanes
5-12 Hydroboration-oxidation of alkenes
5-18 Addition of organometallic compounds to unsaturated alcohols
5-20 Addition of CH_3 and H to allylic alcohols
5-22 Free-radical addition of alcohols to olefins
5-43 Addition of OH and SR to double bonds
6-25 Reduction of aldehydes or ketones
6-29 Addition of Grignard reagents to aldehydes or ketones
6-32 Addition of Grignard reagents to carboxylic esters or acyl halides
6-53 Reductive addition of alkenes to aldehydes
7-2 Alkaline cleavage of ethers
7-39 Reaction of N-substituted amides with certain catalysts
8-1 Rearrangement of alcohols or olefins (Wagner-Meerwein)
8-3 Expansion and contraction of rings (Demyanov)
8-20 Cleavage of methyl ketones with peracids (Baeyer-Villiger)
8-21 Cleavage of hydroperoxides
8-23 Rearrangement of ethers upon treatment with alkyllithiums (Wittig)
8-24 From boranes and CO, or CN^- , or CHCl_2OMe
8-25 From boranes, CO, water, and NaOH
8-26 From boranes, CO, and LiAlH_4
8-37 [2,3] Sigmatropic rearrangements of allylic ethers or allylic sulfoxides
9-9 Reduction of ozonides
9-38 Reduction of carboxylic acids
9-42 Reduction of carboxylic esters
9-43 Reduction of carboxylic esters with titanocene dichloride
9-44 Reduction of anhydrides
9-45 Reduction of acyl halides
9-53 Reduction of nitriles
9-57 Reduction of hydroperoxides
9-60 Reduction of peroxides
9-69 Reaction between aldehydes and base (Cannizzaro)

Aldehydes (*see also* Dicarbonyl Compounds, Unsaturated Carbonyl Compounds, etc.)

- 0-2** Hydrolysis of *gem*-dihalides
0-4 Hydrolysis of enol esters of inorganic acids
0-6 Hydrolysis of enol ethers, acetals, thioacetals, etc.
0-10 Hydrolysis of enol esters
0-83 Reduction of acyl halides
0-84 Reduction of carboxylic acids, esters, or anhydrides
0-85 Reduction of amides
0-95 Alkylation and hydrolysis of imines; alkylation of aldehydes
0-97 Alkylation and hydrolysis of dithianes
0-98 Alkylation and hydrolysis of oxazines and similar compounds
0-99 Reaction of diazo aldehydes with boranes
0-102 Carbonylation of alkyl halides
0-105 Reaction between formates or formamides and organometallic compounds
0-110 Formylation of carboxylic acid salts
0-113 Reaction between formic acid, another acid, and thorium oxide
1-15 Formylation of aromatic rings with formamides and POCl_3 (Vilsmeier)
1-16 Formylation of aromatic rings with $\text{Zn}(\text{CN})_2$ and HCl (Gatterman)
1-17 Formylation of aromatic rings with chloroform (Reimer-Tiemann)
1-18 Other formylations of aromatic rings
2-25 Oxidation of 1,1-dimetallic compounds
2-32 Carbonylation of organometallic compounds

Aldehydes (continued)

- 2-40 Decarboxylation of glycidic acids
 3-15 Carbonylation of aryl iodides
 3-17 Vicarious substitution of aryl nitro compounds
 4-16 Cross-coupling of alkanes with trioxane
 4-20 Arylation of allylic alcohols
 4-31 Reaction of diazonium salts with oximes, followed by hydrolysis
 5-2 Cleavage of activated olefins with water
 5-3 Hydration of acetylene
 5-9 Selective reduction of unsaturated aldehydes
 5-12 Oxidation of boranes; hydrolysis of unsaturated boranes
 5-18 Addition of organometallic compounds to unsaturated aldehydes
 5-19 Addition of boranes to unsaturated aldehydes
 5-24 Hydroformylation of olefins (oxo process)
 6-2 Hydrolysis of imines, oximes, hydrazones, or other C=N compounds
 6-4 Hydrolysis of primary nitro compounds (Nef)
 6-28 Reduction of nitriles
 6-32 Addition of Grignard reagents to formamides
 6-41 Reaction of aldehydes or ketones with boron methides
 6-69 Hydrolysis of metalated aldimines
 7-1 Dehydration of 1,2-diols
 7-2 Pyrolysis of vinylic ethers
 7-32 Fragmentation of γ -amino or γ -hydroxy halides
 7-33 Fragmentation of 1,3-diols
 7-38 Fragmentation of certain ketoximes
 7-43 Pyrolysis of β -hydroxy olefins
 7-44 Pyrolysis of allylic ethers
 8-2 Rearrangements of diols (pinacol)
 8-9 Homologation of aldehydes
 8-14 Reaction between α -hydroxy or α -halo amides and NaOBr (Hofmann)
 8-21 Cleavage of hydroperoxides
 8-23 Rearrangement of allylic ethers
 8-26 Treatment of boranes with CO and LiAl(OMe)₃
 8-32 [1,3] Sigmatropic rearrangements of allylic vinylic ethers

- 8-42 Photolysis of nitrites, followed by hydrolysis (Barton)
 9-3 Oxidation of primary alcohols
 9-7 Oxidative cleavage of glycols or related compounds
 9-9 Ozonolysis of olefins
 9-13 Oxidation of arylacetic acids
 9-16 Oxidation of activated methyl groups
 9-17 Oxidation of arylmethanes (Étard)
 9-20 Oxidation of primary halides or esters of primary alcohols
 9-21 Oxidation of amines or nitro compounds
 9-23 Oxidation of olefins with noble-metal salts
 9-71 Hydrolysis of α -acetoxy sulfides

Alicyclic Compounds

- 0-86 Internal coupling (Wurtz)
 0-88 Cyclization of diallylic halides
 0-90 Cyclization of 1,3-diols
 0-94 Internal malonic ester synthesis
 0-102 Carbonylation of 1,4-dihalides
 0-108 Internal condensation of diesters (Dieckmann)
 0-113 Ketonic decarboxylation of dicarboxylic acids
 1-12 Intramolecular Friedel-Crafts alkylation
 1-13 Scholl ring closure
 1-14 Intramolecular Friedel-Crafts acylation
 1-23 Cyclodehydration of aldehydes and ketones
 2-16 Intramolecular insertion of carbocations
 2-20 Intramolecular insertion of carbenes
 3-16 Cyclization of dihalobiphenyls
 4-17 Coupling of terminal diynes (cycloalkynes)
 4-18 Intramolecular arylation (Pschorr)
 4-33 Cyclization of dimagnesium compounds
 5-10 Reduction of aromatic rings
 5-15 Cyclization of dienes or diynes
 5-18 Cyclization of unsaturated Grignard reagents
 5-20 Free radical cyclization of alkenes with tin or mercury halides

Alicyclic Compounds (continued)

- 5-22 Cyclization of unsaturated aldehydes
- 5-24 Carbonylation of dienes
- 5-33 Cyclization of halo olefins
- 5-47 Addition of olefins to dienes (Diels-Alder)
- 5-48 All-carbon 2 + 3 cycloadditions
- 5-49 Dimerization of olefins
- 5-50 Addition of carbenes or carbenoids to olefins or alkynes
- 5-51 Tetramerization of alkynes
- 5-52 Other cycloaddition reactions
- 6-29 Ring closure of halo carbonyl compounds
- 6-32 Reaction between carboxylic esters and dimagnesium compounds
- 6-39 Internal aldol reactions
- 6-47 Internal Wittig reactions
- 6-48 Cyclization of dinitriles (Thorpe-Ziegler)
- 7-46 Extrusion of N₂ from pyrazolines or pyrazoles
- 7-47 Extrusion of CO from cyclic ketones
- 7-48 Extrusion of SO₂ from cyclic sulfones
- 7-49 Decarboxylation of cyclic peroxides (Story)
- 8-1 Wagner-Meerwein rearrangements to give cyclic products
- 8-3 Expansion and contraction of rings
- 8-7 Ring contraction of halo ketones (Favorskii)
- 8-8 Ring contraction of cyclic diazo ketones (Wolff)
- 8-9 Ring expansion of cyclic ketones
- 8-24 Treatment of cyclic boranes with CO
- 8-29 Cyclization of conjugated dienes and trienes
- 8-32 [1,*j*] Sigmatropic migrations of carbon
- 8-33 Ring expansion of vinylcyclopropanes and cyclobutenes
- 8-34 Ring expansion of vinylcycloalkanes; cyclization of diynes
- 8-39 Metathesis of dienes
- 8-40 Metal-ion-catalyzed σ -bond rearrangements
- 8-41 The di- π -methane rearrangement
- 9-2 Dehydrogenative ring closing
- 9-33 Oxidative cyclization
- 9-62 Reductive cyclization of dialdehydes
- 9-64 Cyclization of diketones or keto esters
- 9-65 Condensation of diesters (acyloin)

Alkanes (see also Alicyclic Compounds)

- 0-76 Reduction of alkyl halides
- 0-77 Reduction of tosylates and similar compounds
- 0-78 Hydrogenolysis of alcohols
- 0-81 Reductive cleavage of carboxylic esters
- 0-82 Reduction of the C—N bond
- 0-86 Coupling of alkyl halides (Wurtz)
- 0-87 Coupling of alkyl halides with organometallic reagents
- 0-89 Reaction between organometallic reagents and alkyl sulfates or sulfonates
- 0-90 Coupling of alcohols
- 0-92 Reaction between Grignard reagents and ethers
- 0-97 Reduction of dithianes
- 2-18 Alkylation of alkanes
- 2-20 Insertion of carbenes
- 2-24 Reaction between organometallic compounds and acids
- 2-40 Decarboxylation of carboxylic acids
- 2-41 Cleavage of tertiary alkoxides
- 2-45 Cleavage of nonenolizable ketones
- 2-46 Cleavage of ketones with amide ion (Haller-Bauer)
- 2-47 Cleavage of alkanes
- 2-48 Decyanation of nitriles
- 4-16 Coupling of alkanes
- 4-33 Coupling of Grignard reagents
- 4-34 Coupling of boranes
- 4-35 Coupling of other organometallic compounds
- 4-36 Desulfurization of sulfur compounds
- 4-38 Decarboxylative dimerization (Kolbe)
- 4-41 Decarbonylation of aldehydes or acyl halides
- 5-9 Reduction of olefins and alkynes
- 5-10 Reduction of aromatic rings
- 5-11 Reductive cleavage of cyclopropanes
- 5-14 Addition of alkanes to olefins
- 5-15 Dimerization of alkenes

Alkanes (continued)

- 6-29 Reaction of ketones with trimethylaluminum
- 6-32 Reaction of carboxylic acids with trimethylaluminum
- 7-47 Extrusion of CO₂ from diacyl peroxides
- 9-6 Oxidation of hydrazines
- 9-13 Oxidative decarboxylation of carboxylic acids
- 9-37 Reduction of aldehydes or ketones (Wolff-Kishner; Clemmensen)
- 9-43 Reduction of carboxylic acids or esters
- 9-46 Reduction of epoxides
- 9-53 Reduction of cyano to methyl groups

Alkenes (see also Alicyclic Compounds, Unsaturated Acids, Unsaturated Alcohols, etc.)

- 0-76 Reduction of unsaturated halides
- 0-78 Reduction of allylic alcohols
- 0-82 Reductive cleavage of enamines
- 0-86 Coupling of vinylic halides
- 0-87 Coupling of unsaturated halides with organometallic reagents
- 0-88 Coupling of allylic halides, tosylates, or acetates
- 0-89 Coupling of vinylic triflates with organometallic reagents
- 0-90 Coupling of allylic alcohols with organometallic reagents
- 0-91 Coupling of allylic esters with organometallic reagents
- 0-92 Cleavage of allylic, vinylic or silyl ethers
- 2-2 Migration of double and triple bonds
- 2-40 Decarboxylation of unsaturated acids
- 4-19 Arylation of olefins (Meerwein)
- 4-20 Arylation of olefins by organopalladium compounds
- 4-30 Vinylation of diazonium salts
- 4-33 Dimerization of allylic Grignard reagents
- 4-34 Dimerization of vinylic chloroboranes
- 4-35 Dimerization of vinylic organometallic reagents
- 4-36 Desulfurization of thiophenes

- 4-38 Additive dimerization of olefins and carboxylic acids
- 5-9 Selective reduction of alkynes or alkenes
- 5-10 Reduction of aromatic rings
- 5-12 Reduction of vinylic boranes; hydroboration of enamines
- 5-15 Dimerization of olefins; dimerization of alkynes
- 5-16 The ene synthesis
- 5-18 Reaction of allylic halides, alkynes, and zinc
- 5-47 Addition of olefins to dienes (Diels-Alder)
- 5-50 Addition of carbenes to aromatic rings
- 5-51 Tetramerization of alkynes
- 5-52 Dimerization of dienes
- 5-53 Addition of two alkyl groups to an alkyne
- 5-55 Reaction of diphenylacetylene with methylsulfinyl carbanion
- 6-29 Reaction of *gem*-dimetallic compounds or organolithium compounds with aldehydes or ketones
- 6-30 Reformatsky reaction with Bu₃P
- 6-34 Reaction of ketones with Tebbe's reagent
- 6-41 From tosylhydrazone salts
- 6-42 Addition to aldehydes or ketones of α -sulfinyl carbanions or of α -lithiosilanes (Peterson)
- 6-47 Reaction between phosphorus ylides and aldehydes or ketones (Wittig)
- 6-62 Reaction of sulfonyl halides with tertiary amines and diazoalkanes
- 7-1 Dehydration of alcohols
- 7-2 Alkaline cleavage of ethers
- 7-3 Pyrolysis of carboxylic esters
- 7-4 Pyrolysis of xanthates (Chugaev)
- 7-5 Cleavage of inorganic esters and sulfonates
- 7-6 Cleavage of quaternary ammonium hydroxides (Hofmann)
- 7-7 Cleavage of quaternary ammonium salts
- 7-8 Cleavage of amine oxides (Cope)
- 7-9 Cleavage of aliphatic diazonium salts
- 7-10 Decomposition of tosylhydrazones
- 7-11 Cleavage of sulfonium compounds

Alkenes (continued)

- 7-12 Cleavage of sulfoxides, selenoxides, and sulfones
- 7-13 Dehydrohalogenation of alkyl halides
- 7-14 Reaction of sulfonyl halides with tertiary amines
- 7-15 Elimination of boranes
- 7-16 Elimination of HM from organometallic compounds
- 7-19 Decarbonylation of acyl halides
- 7-20 Cleavage of Michael adducts
- 7-21 Deoxygenation of *vic*-diols
- 7-22 Cleavage of cyclic thionocarbonates
- 7-23 Deoxidation of epoxides
- 7-24 Desulfurization of episulfides
- 7-25 Reaction of α -halo sulfones with bases (Ramberg-Bäcklund)
- 7-26 Reaction of aziridines with nitrous acid
- 7-27 Denitration of *vic*-dinitro compounds
- 7-29 Dehalogenation of *vic*-dihalides
- 7-31 Elimination of a halo and a hetero group (Boord)
- 7-32 Fragmentation of γ -amino or γ -hydroxy halides
- 7-33 Fragmentation of 1,3-diols
- 7-34 Decarbonylation of β -hydroxy carboxylic acids and of β -lactones
- 7-36 Elimination of CO and CO₂ from bridged bicyclic compounds
- 7-43 Pyrolysis of β -hydroxy olefins
- 7-44 Pyrolysis of allylic ethers
- 7-51 Twofold extrusion from certain cyclic molecules
- 8-1 Rearrangement of alcohols and olefins (Wagner-Meerwein)
- 8-3 Expansion and contraction of rings (Demyanov)
- 8-8 Rearrangement of carbenes or carbenoids
- 8-27 Reaction between vinylic boranes and iodine or NaOMe
- 8-28 Reaction of lithium alkynyltrialkylborates with electrophiles
- 8-29 Electrocyclic rearrangements of cyclobutenes and cyclohexadienes
- 8-31 [1,*j*] Sigmatropic migrations of hydrogen
- 8-32 [1,*j*] Sigmatropic migrations of carbon
- 8-33 Rearrangement of vinylcyclopropanes
- 8-34 Rearrangement of 1,5-dienes (Cope)
- 8-39 Metathesis of olefins
- 8-40 Cyclobutane reversions
- 8-41 The di- π -methane rearrangement
- 9-2 Dehydrogenation of diarylalkanes; remote dehydrogenation
- 9-13 Oxidative decarboxylation of carboxylic acids
- 9-14 Bisdecarboxylation of succinic acids
- 9-33 Oxidative coupling of halides
- 9-37 Reduction of α -hydroxy ketones; of unsaturated tosylhydrazones
- 9-64 Bimolecular reduction of aldehydes or ketones
- Alkyl Halides** (*see also* Dihalides, Haloaldehydes, etc.)
- 0-65 Halide exchange (Finkelstein)
- 0-66 Reaction between inorganic esters and halide ions
- 0-67 Reaction between alcohols and hydrogen halides or inorganic acid halides
- 0-68 Cleavage of ethers with HI or HBr
- 0-70 Cleavage of carboxylic esters with LiI
- 0-72 Conversion of amines to halides
- 0-73 Cleavage of tertiary amines (von Braun)
- 0-76 Reduction of dihalides
- 0-80 Reductive halogenation of epoxides
- 0-92 Homologation of alkyl halides
- 0-97 Homologation of alkyl halides
- 1-12 Reaction between aromatic rings and carbon tetrachloride
- 1-24 Haloalkylation of aromatic rings
- 2-30 Halogenation of organometallic compounds
- 2-39 Exchange between halides and organometallic compounds
- 4-1 Free-radical halogenation
- 4-2 Allylic halogenation
- 4-39 Decarboxylative halogenation (Hunsdiecker)
- 5-1 Addition of hydrogen halides to alkenes or alkynes
- 5-22 Free-radical addition of alkyl halides to olefins

Alkyl Halides (continued)

- 5-26** Addition of halogens to olefins or alkynes
5-33 Addition of alkyl or aryl halides to olefins
6-24 Reductive halogenation of aldehydes
6-29 Addition of methyl niobium reagents to ketones
7-39 Reaction of N-substituted amides with PCl_5 (von Braun)

Alkynes (see also Alkynyl Halides, Alkynyl Ethers)

- 0-78** Reduction of acetylenic alcohols
0-87 From allenic substrates, with organocopper reagents
0-88 Propargylation of alkyl halides
0-100 Alkylation at an alkynyl carbon
2-2 Triple-bond migration
2-40 Decarboxylation of acetylenic acids
3-13 Reaction between aryl iodides and copper acetylides
4-17 Coupling of alkynes (Eglinton)
4-20 Arylation of alkynes
4-33 Dimerization of alkynyl organometallic compounds
4-34 Coupling of alkynyl borates
7-6 Pyrolysis of bisquaternary ammonium hydroxides
7-12 Cleavage of selenoxides
7-13 Dehydrohalogenation of dihalides or vinylic halides
7-17 Elimination of the elements of CH_4 from certain alkenes
7-25 Decomposition of thiiren-1,1-dioxides
7-28 Reaction of bistosylhydrazones with metallic oxides
7-29 Dehalogenation of tetrahalides
8-28 From boranes and lithium acetylides
8-39 Metathesis of alkynes
9-2 Dehydrogenation of certain diaryl alkenes
9-33 Oxidation of dihalotoluenes

Alkynyl Ethers

- 7-13** Reaction between vinylidene dihalides and amide ion

Alkynyl Halides

- 2-30** Reaction of acetylide ions with halogens

Allenes

- 0-76** Reduction of propargyl halides
0-81 Reduction of propargyl acetates
0-88 Alkylation of propargyl halides
0-89 Alkylation of propargyl tosylates
0-91 Reaction between propargyl esters and organometallic reagents
0-92 Cleavage of propargyl ethers by Grignard reagents
2-2 Rearrangement of alkynes
6-47 Reaction of phosphoranes with ketenes or CO_2
7-13 Dehydrohalogenation of dihalides
7-29 Dehalogenation of tetrahalides or dihaloalkenes
7-43 Pyrolysis of β -hydroxy alkynes
8-3 Contraction of three-membered rings
8-35 Rearrangement of propargylic vinyl compounds

Amidals (see Bisamides)**Amides** (see also Bisamides)

- 0-11** Cleavage of an alkyl group from N-*t*-butyl amides
0-51 Reaction between secondary amines and chloroform
0-52 Amination of acyl halides
0-53 Amination of anhydrides
0-54 Amination of carboxylic acids
0-55 Amination of carboxylic esters
0-56 Amination of amides
0-57 Amination of other acid derivatives
0-58 N-Alkylation of amides
0-103 Carbonylation of alkyl halides
1-6 Amidation of aromatic rings with hydroxamic acids
1-19 Carbamoylation of aromatic rings (Gatterman)
1-21 Amidation of aromatic rings with isocyanates
1-25 Amidoalkylation of aromatic rings
1-35 Rearrangement of N-halo-N-acyl aromatic amines (Orton)
2-12 Insertion by nitrenes
2-31 Indirectly from aldehydes
2-32 From imines, CO, and a borane
2-42 Reaction between amino acids and anhydrides (Dakin-West)
2-46 Cleavage of ketones with amide ion (Haller-Bauer)

Amides (continued)

- 2-48 Decyanation of cyano amides
- 2-55 Carbonylation of amines
- 3-6 N-Arylation of amides
- 3-15 Carboamidation of aryl halides
- 4-14 Reaction of aldehydes with ammonia
- 4-15 Amidation at an alkyl carbon
- 4-23 Carboamidation of nitrogen heterocycles
- 5-3 Hydration of ynamines
- 5-7 Addition of amides to olefins; addition of amines to ketenes
- 5-22 Free-radical addition of amides to olefins
- 5-23 Hydrocarboxylation of olefins in the presence of amines
- 6-5 Partial hydrolysis of nitriles
- 6-15 Reductive alkylation of amines (Leuckart)
- 6-18 Addition of amines and water to nitriles
- 6-26 Reduction of isocyanates
- 6-36 Addition of Grignard reagents to isocyanates
- 6-55 Addition of alcohols or other carbocation sources to nitriles (Ritter)
- 6-65 Addition of water to isocyanides
- 8-7 Rearrangement of α -halo ketones in the presence of amines (Favorskii)
- 8-8 Rearrangement of diazo ketones in the presence of amines (Arndt-Eistert)
- 8-14 Reaction between amides, lead tetraacetate, and acetic acid
- 8-17 Reaction between ketones and hydrazoic acid (Schmidt)
- 8-18 Rearrangement of oximes (Beckmann)
- 8-44 Rearrangement of aryl imidates (Chapman)
- 9-18 Oxidation of tertiary amines
- 9-72 Oxidation of aryl ketones with ammonium polysulfide (Willgerodt)

Amidines

- 0-55 Amination of imidates
- 5-7 Addition of amines to ketenimines
- 6-18 Addition of ammonia or amines to nitriles

Amido Ketones

- 5-44 Addition of an acyl group and an acylamino group to a double bond

Aminals

- 6-14 Addition of amines to aldehydes or ketones

Amine Oxides

- 9-28 Oxidation of tertiary amines

Amines (*see also* Cyanoamines, Amino Acids, etc.)

- 0-11 Hydrolysis of amides
- 0-36 Cleavage of amines or quaternary ammonium salts
- 0-43 Alkylation of ammonia or amines
- 0-44 Reaction between alkyl halides and hexamethylenetetramine (Delépine)
- 0-45 Reaction of alkyl halides with cyanamide
- 0-46 From alcohols or ethers
- 0-47 Transamination
- 0-48 Alkylation of amines with diazo compounds
- 0-50 Amination of alkanes
- 0-58 Hydrolysis of phthalimides (Gabriel); etc.
- 0-63 Hydrolysis of bis(trimethylsilyl)-amines
- 0-72 Cleavage of aromatic amines or quaternary ammonium salts
- 0-82 Reduction of quaternary ammonium salts or aziridines
- 0-92 Cleavage of amine ethers with organometallic compounds
- 0-93 Reaction of organometallic compounds with aziridines
- 0-97 Alkylation of amines
- 0-114 Hydrolysis of sulfonamides
- 1-6 Direct amination of aromatic rings
- 1-25 Aminoalkylation of aromatic rings
- 1-32 Rearrangement of N-nitroamines
- 1-33 Rearrangement of N-nitrosoamines (Fischer-Hepp)
- 1-34 Rearrangement of triazenes
- 1-36 Rearrangement of arylamines or aryl alkyl ammonium salts
- 2-11 Amination at an activated position

Amines (continued)

- 2-31** Conversion of organometallic compounds to amines
- 2-40** Decarboxylation of amino acids
- 2-48** Decyanation of cyanoamines
- 3-6** Arylation of ammonia or amines
- 3-7** Reaction between naphthols, bisulfite ion, and ammonia or amines (Bucherer)
- 3-18** Amination of heterocyclic nitrogen compounds (Chichibabin)
- 3-19** Direct amination of activated aromatic rings
- 3-26** Rearrangement of benzylic quaternary ammonium salts (Sommelet-Hauser)
- 3-27** Rearrangement of aryl hydroxylamines
- 4-10** Demethylation of tertiary amines
- 4-36** Desulfurization of thioamides
- 5-7** Addition of ammonia or amines to olefins
- 5-18** Addition of organometallic compounds to allylic amines
- 5-22** Free-radical addition of amines to olefins
- 5-41** Diamination of alkenes
- 5-43** Addition of R_2N and SR to double bonds
- 6-2** Hydrolysis of imines, enamines, and iminium ions
- 6-3** Hydrolysis of isocyanates or isothiocyanates
- 6-5** Hydrolysis of cyanamides
- 6-13** Addition of ammonia to aldehydes
- 6-15** Reductive alkylation of ammonia or amines
- 6-16** Reaction between aldehydes, ammonia or amines, and an active hydrogen compound (Mannich)
- 6-26** Reduction of imines, hydrazones, or other compounds containing the $C=N$ bond
- 6-27** Reduction of nitriles or nitrilium ions
- 6-29** Addition of organometallic compounds to amides
- 6-32** Addition of Grignard reagents to formamides
- 6-35** Addition of Grignard reagents to imines
- 6-66** Reduction of isocyanides
- 7-6** Cleavage of quaternary ammonium hydroxides (Hofmann)
- 7-7** Cleavage of quaternary ammonium salts
- 7-38** Fragmentation of certain ketoximes
- 8-14** Reaction between amides and $NaOBr$ (Hofmann)
- 8-15** Rearrangement of acyl azides in the presence of water (Curtius)
- 8-16** Rearrangement of hydroxamic acids and acyl halides (Lossen)
- 8-17** Addition of hydrazoic acid to carboxylic acids (Schmidt)
- 8-19** Rearrangement of N-haloamines
- 8-22** Rearrangement of quaternary ammonium salts and tertiary benzylic amines (Stevens)
- 8-37** [2,3] Sigmatropic rearrangements of quaternary ammonium salts
- 8-38** Rearrangement of benzidines
- 8-42** Hofmann-Löffler and related reactions
- 9-5** Conversion of primary to secondary amines by dehydrogenation
- 9-9** Reaction between ozonides, ammonia, and hydrogen
- 9-21** Oxidative cleavage of amines
- 9-39** Reduction of amides
- 9-47** Reduction of nitro compounds
- 9-50** Reduction of nitroso compounds or hydroxylamines
- 9-51** Reduction of oximes
- 9-52** Reduction of azides
- 9-53** Reduction of isocyanates, isothiocyanates, or N-nitroso compounds
- 9-55** Reduction of amine oxides
- 9-59** Reduction of azo, azoxy, or hydrazo compounds
- 9-62** Bimolecular reduction of imines (1,2-diamines)

Amino Acids and Esters

- 0-11** Hydrolysis of lactams
- 0-43** Amination of halo acids
- 0-55** Ammonolysis of β -lactones
- 0-94** Alkylation of N-acetylaminomalonic esters (Sorensen)
- 2-8** Nitrosation at a carbon bearing an active hydrogen and reduction of the

Amino Acids and Esters (continued)

- resulting oxime or nitroso compound
- 2-11** From acyl halides and a dialkyl azodicarboxylate
- 6-5** Hydrolysis of cyanohydrins
- 6-16** Reaction between aldehydes, ammonia, and carboxylic acids or esters
- 6-50** Addition of cyanide and ammonium ions to aldehydes or ketones, followed by hydrolysis (Strecker)
- 8-14** Reaction between imides and NaOBr (Hofmann)

Amino Carbonyl Compounds

- 0-46** Amination of α -hydroxy ketones
- 0-47** Transamination of Mannich bases
- 1-36** Photolysis of acylated arylamines
- 6-16** Reaction between aldehydes, ammonia, and aldehydes, ketones, or esters (Mannich)
- 8-13** Rearrangement of ketoxime tosylates (Neber)
- 8-22** Rearrangement of quaternary ammonium salts (Stevens)
- 9-23** Oxidation of certain enamines

Amino Ethers

- 0-18** Alcoholysis of aziridines
- 5-39** Aminomercuration of alkenes, followed by alcoholysis
- 6-16** Reaction between aldehydes, amines, and alcohols or phenols (Mannich)

Amino Thiols

- 0-49** Amination of episulfides
- 1-9** Sulfurization of aromatic amines (Herz)
- 6-16** Reaction between an aldehyde, ammonia, and a thiol (Mannich)

Anhydrides

- 0-27** Reaction of acyl halides with acid salts
- 0-28** Dehydration of carboxylic acids
- 0-33** Reaction of acid derivatives with inorganic acids
- 3-15** From aryl halides and CO
- 4-11** Acyloxylation of aldehydes

- 4-31** Reaction between diazonium fluoroborates, CO, and an acid salt
- 5-5** Addition of carboxylic acids to ketenes
- 5-22** Free-radical addition of anhydrides to olefins
- 8-20** Reaction between α -diketones and peroxy compounds (Baeyer-Villiger)
- 9-10** Oxidation of aromatic rings

Arenes

- 0-76** Reduction of aryl and benzylic halides
- 0-78** Hydrogenolysis of benzyl alcohols
- 0-79** Reduction of benzylic ethers
- 0-86** Coupling of halides containing aryl groups
- 0-87** Coupling of aryl halides with organometallic reagents
- 0-90** Coupling of benzylic alcohols
- 1-12** Alkylation of aromatic rings (Friedel-Crafts)
- 1-13** Arylation of aromatic rings (Scholl)
- 1-22** Diarylation of ketones
- 1-23** Ring closure of aryl-substituted carbonyl compounds
- 1-37** Cleavage or rearrangement of alkyl arenes
- 1-38** Decarbonylation of aromatic aldehydes or deacylation of aromatic ketones
- 1-39** Decarboxylation of aromatic acids
- 1-41** Desulfonation of aromatic sulfonic acids
- 1-42** Dehalogenation of aryl halides
- 1-44** Hydrolysis of organometallic compounds
- 2-40** Decarboxylation of α -aryl acids
- 2-41** Cleavage of tertiary alkoxides
- 2-45** Cleavage of aryl ketones
- 2-46** Cleavage of aryl ketones with amide ions (Haller-Bauer)
- 2-48** Decyanation of aryl nitriles
- 3-9** Reduction of phenols, phenolic ethers, or phenolic esters
- 3-10** Reduction of aromatic nitro compounds
- 3-13** Coupling of organometallic compounds with aryl halides, ethers, and esters

Arenes (continued)

- 3-16** Coupling of aryl iodides (Ullmann)
- 3-17** Alkylation with organometallic compounds
- 4-18** Free-radical arylation by diazonium salts (Gomberg-Bachmann, Pschorr)
- 4-21** Free-radical arylation by peroxides
- 4-22** Photochemical arylation
- 4-24** Reduction of diazonium salts
- 4-29** Dimerization of diazonium salts
- 4-30** Methylation of diazonium salts
- 4-33** Coupling of Grignard reagents
- 4-34** Coupling of arylboranes
- 4-35** Coupling of other organometallic compounds
- 4-36** Reduction of sulfur compounds
- 4-38** Coupling of aromatic acyl halides, with decarbonylation
- 4-41** Decarbonylation of aromatic aldehydes
- 5-20** Addition of tin and mercury hydrides to aryl alkenes
- 5-51** Trimerization of alkynes
- 6-29** Alkylation-reduction of aromatic aldehydes and ketones
- 7-36** Diels-Alder reactions of cyclopentadienones with alkynes
- 8-30** Photoconversion of stilbenes to phenanthrenes
- 9-1** Aromatization of six-membered rings
- 9-6** Oxidation of hydrazines
- 9-33** Dimerization of arenes
- 9-37** Reduction of aromatic aldehydes
- 9-43** Reduction of aromatic acids

Aryl Halides

- 1-11** Halogenation of aromatic compounds
- 1-35** Rearrangement of N-haloamines (Orton)
- 1-39** Replacement of aromatic COOH by halogen
- 1-41** Replacement of aromatic SO₂Br by halogen
- 1-42** Migration of halogen
- 2-30** Reaction of aryl organometallic compounds with halogens
- 3-8** Aryl halide exchange; halo-de-nitration; halo-de-hydroxylation

- 3-23** Reaction between diazonium salts and iodide ion
- 3-24** Heating of diazonium fluoroborates (Schiemann)
- 4-25** Reaction between diazonium salts and CuCl or CuBr (Sandmeyer)
- 4-39** Decarboxylative halogenation (Hunsdiecker)
- 4-41** Decarbonylation of acyl halides

Azides

- 0-61** Alkylation or acylation of azide ion
- 2-10** Treatment of amides with tosyl azide
- 2-50** Reaction between hydrazines and nitrous acid
- 3-22** Reaction of diazonium salts with azide ion
- 4-39** Reaction of acyl peroxides with copper azide
- 5-8** Addition of hydrazoic acid to double bonds
- 5-31** Addition of halogen azides to double bonds
- 5-41** Treatment of olefins with sodium azide, ferrous ion, and hydrogen peroxide
- 5-43** Addition of SR and N₃ to double bonds
- 8-15** Reaction between hydrazides and nitrous acid
- 8-17** Reaction between alcohols or olefins and hydrazoic acid

Azido Amides

- 2-10** Azidation of amides

Azines

- 6-20** Addition of hydrazine to aldehydes or ketones

Aziridines

- 0-43** Cyclization of haloamines
- 0-46** Cyclization of amino alcohols
- 0-61** Cyclization of β-azido alcohols
- 5-31** From β-iodo azides
- 5-42** Reaction of alkenes with azides
- 6-45** Reaction of imines with α-halo carbonyl compounds
- 7-46** Extrusion of N₂ from triazolines
- 9-51** Reduction of oximes

Azo Compounds

- 1-4 Coupling of diazonium salts with aromatic rings
 1-34 Rearrangement of aryl triazenes
 2-7 Aliphatic diazonium coupling
 2-52 Reaction of amines with nitroso compounds (Mills)
 2-53 From aromatic nitro compounds
 4-29 Coupling of aryl diazonium salts
 8-45 Rearrangement of azoxy compounds (Wallach)
 9-6 Oxidation of hydrazines
 9-36 Oxidation of amines
 9-55 Reduction of azoxy compounds
 9-67 Reduction of nitro compounds

Azoxy Compounds

- 0-64 Reaction between alkyl halides and alkanediazotates
 2-53 Reaction of nitroso compounds with hydroxylamines
 9-29 Oxidation of azo compounds
 9-36 Oxidation of amines
 9-66 Reduction of nitro or nitroso compounds; reaction between nitroso compounds and hydroxylamines

Benzoin (*see* Hydroxy Aldehydes and Ketones)

Bisamides

- 4-16 Coupling of amides
 6-14 Addition of amides to aldehydes or ketones
 6-67 Reaction between isocyanides, acids, amines, and aldehydes or ketones (Ugi)

Bis(trimethylsilyl)amines

- 0-63 Reaction between halides or tosylates and $(\text{Me}_3\text{Si})_2\text{NNa}$

Bisulfite Addition Compounds (*see* Hydroxy Sulfonic Acids)

Boranes

- 2-35 Reaction between boron halides and Grignard reagents
 5-12 Hydroboration of olefins or alkynes
 5-19 Reaction of borinates with organometallic compounds

- 7-15 Exchange reaction between boranes and olefins

- 8-11 Migration of boron

Bunte Salts

- 0-39 Reaction between alkyl halides and thiosulfate ion

Carbamates

- 0-24 Reaction between K_2CO_3 , amines, and halides
 0-52 Reaction between chloroformates and primary amines
 0-62 Reaction between alkyl halides, ethanol, and thiocyanate ion
 0-72 Cleavage of tertiary amines with ClCOOPh
 2-12 Insertion by nitrenes
 2-55 Carbonylation of amines or nitro or nitroso compounds
 6-8 Addition of alcohols to isocyanates
 6-9 Reaction of alcohols with ClCN
 6-68 Addition of alkyl hypochlorites to isocyanides
 8-14 Reaction between amides, bromine, and alkoxides (Hofmann), and similar rearrangement reactions
 8-15 Rearrangement of acyl azides in the presence of alcohols (Curtius)

Carbodiimides

- 6-58 Addition of isocyanates to isocyanates
 7-42 Dehydration of ureas and thioureas

Carbonates

- 0-20 Alcoholysis of phosgene
 0-24 Reaction between alkyl halides and carbonate salts

Carboxylic Acids

- 0-3 Hydrolysis of 1,1,1-trihalides
 0-6 Hydrolysis of ortho esters
 0-8 Hydrolysis of acyl halides
 0-9 Hydrolysis of anhydrides
 0-10 Hydrolysis of carboxylic esters
 0-11 Hydrolysis of amides
 0-70 Cleavage of carboxylic esters with LiI
 0-81 Reductive cleavage of carboxylic esters

Carboxylic Acids (continued)

- 0-94** Malonic ester synthesis
0-96 Alkylation of carboxylate ions
0-98 Hydrolysis of oxazines
0-103 Carbonylation of alkyl halides and other substrates
1-19 Carbonylation of aromatic rings with carbonyl halides
1-20 Carboxylation of aromatic rings with carbon dioxide (Kolbe-Schmitt)
1-39 Rearrangement of aromatic carboxylate ions
2-40 Decarboxylation of dicarboxylic acids
2-43 Basic cleavage of β -keto esters or β -diketones
2-44 The haloform reaction
2-45 Cleavage of nonenolizable ketones
3-15 Carboxylation of aryl halides
3-25 Rearrangement of aromatic nitro compounds upon treatment with cyanide ion (von Richter)
4-6 Oxidation of aldehydes
4-31 Reaction of diazonium fluoroborates with CO
5-2 Addition of water to ketenes
5-12 Oxidation of 1,1-diboranes
5-14 Addition of carbocations to 1,1-dichloroethene; addition of carboxylates to olefins
5-18 Addition of alkylcopper reagents to unsaturated carboxylic acids
5-22 Free-radical addition of acids to olefins
5-23 Hydrocarboxylation of olefins
6-4 Hydrolysis of primary nitro compounds
6-5 Hydrolysis of nitriles
6-34 Addition of Grignard reagents to carbon dioxide
6-41 Reaction of ketones with tosylmethyl azide, followed by hydrolysis
6-47 Reaction of phosphoranes with CO₂
7-3 Pyrolysis of carboxylic esters
7-38 Fragmentation of certain ketoximes
8-7 Rearrangement of α -halo ketones (Favorskii)
8-8 Rearrangement of diazo ketones (Arndt-Eistert)
8-20 Oxidation of aldehydes
8-26 From boranes
- 9-7** Oxidative cleavage of α -diketones and α -keto acids
9-8 Oxidative cleavage of ketones and secondary alcohols
9-9 Oxidation of ozonides; ozonolysis of alkynes
9-10 Oxidative cleavage of olefins, terminal alkynes, or aromatic rings
9-11 Oxidation of aromatic side chains
9-21 Oxidation of amines
9-22 Oxidation of primary alcohols or ethers
9-23 Oxidation of arylthioalkynes
9-44 Reduction of anhydrides
9-69 Reaction between aldehydes and base (Cannizzaro)
9-72 Oxidation of aryl ketones by ammonium polysulfide (Willgerodt)
- Carboxylic Esters** (*see also* Dicarboxylic Compounds, Unsaturated Esters, etc.)
- 0-3** Alcoholysis of trihalides
0-6 Hydrolysis of ortho esters
0-20 Alcoholysis of acyl halides
0-21 Alcoholysis of anhydrides
0-22 Esterification of carboxylic acids
0-23 Transesterification
0-24 Alkylation of carboxylic acid salts
0-25 Cleavage of ethers with anhydrides
0-26 Alkylation of carboxylic acids with diazo compounds
0-95 Alkylation of carboxylic esters
0-97 Alkylation of aryl esters
0-98 Alkylation and alcoholysis of oxazines
0-99 Reaction of halo esters or diazo esters with boranes
0-103 Carbonylation of alkyl halides and other substrates
0-104 Reaction between Grignard reagents and chloroformates
2-32 Carbonylation of organometallic compounds
2-43 Base cleavage of β -keto esters
2-44 Haloform cleavage of methyl ketones
3-4 Reaction between aryl halides and carboxylic acid salts
3-14 Arylation of carboxylic esters
3-15 Carbalkoxylation of aryl halides and phenols

Carboxylic Esters (continued)

- 3-17 Vicarious substitution of aryl nitro compounds
- 4-11 Free-radical acyloxylation
- 4-23 Carbalkoxylation of nitrogen heterocycles
- 4-39 Reaction between silver salts and iodine (Simonini)
- 5-3 Hydration of acetylenic ethers
- 5-4 Addition of alcohols or phenols to ketenes
- 5-5 Addition of carboxylic acids or acyl peroxides to olefins
- 5-17 Addition of carboxylic esters to activated olefins (Michael)
- 5-18 Addition of organometallic compounds to unsaturated esters
- 5-20 Addition of tin and mercury hydrides to unsaturated ketones
- 5-22 Free-radical addition of carboxylic esters to olefins
- 5-23 Hydrocarboxylation of olefins in the presence of alcohols
- 5-35 Addition of carboxylic acid salts to olefins
- 5-43 Addition of OAc and SR to double bonds
- 5-54 Dicarbalkoxylation of olefins and acetylenes
- 6-7 Reductive acylation of ketones
- 6-9 Alcoholysis of nitriles
- 8-7 Rearrangement of α -halo ketones (Favorskii)
- 8-8 Rearrangement of diazo ketones in the presence of alcohols (Arndt-Eistert)
- 8-20 Reaction between ketones and peroxy compounds (Baeyer-Villiger)
- 9-8 Cleavage of cyclic ketones with NOCl and an alcohol
- 9-9 From ozonides
- 9-10 Oxidative cleavage of enol ethers
- 9-13 Reaction between carboxylic acids and lead tetraacetate
- 9-18 Oxidation of ethers
- 9-22 Oxidation of primary alcohols or aldehydes
- 9-23 Oxidation of enol ethers
- 9-70 Reaction between aldehydes and aluminum ethoxide (Tishchenko)
- 9-72 Reaction of acetophenones with $\text{AgNO}_3\text{-I}_2$ or other reagents

Catenanes

- 9-65 Acyloin condensation or other methods

Cyanamides

- 0-45 Reaction between alkyl halides and cyanamide
- 0-73 Cleavage of tertiary amines with cyanogen bromide (von Braun)
- 7-39 Dehydration of disubstituted ureas

Cyanates

- 0-12 Reaction of aroxides and cyanogen halides

Cyanoamines

- 0-46 Amination of cyanohydrins
- 1-28 Cyanation of aromatic amines
- 2-17 Cyanation of secondary amines
- 6-16 Reaction between aldehydes, ammonia, and nitriles (Mannich)
- 6-50 Addition of cyanide and ammonium ions to aldehydes or ketones (Strecker)
- 6-51 Addition of HCN to $\text{C}=\text{N}$ or $\text{C}\equiv\text{N}$ bonds

Cyano Carbonyl Compounds

- 0-94 Akylation of cyano carbonyl compounds
- 0-107 Acylation of nitriles by acyl halides
- 0-109 Acylation of nitriles by carboxylic esters
- 0-111 Reaction between acyl halides and CuCN
- 2-17 Cyanation of ketones
- 2-19 Cyanoethylation of enamines; reaction of enamines with cyanogen chloride
- 3-14 Arylation of cyano carbonyl compounds
- 5-17 Addition of olefins (Michael)
- 5-21 Acylation of unsaturated nitriles
- 5-25 Addition of HCN to unsaturated aldehydes, ketones, or carboxylic esters
- 6-41 Addition of cyano carbonyl compounds to aldehydes or ketones (Knoevenagel)
- 6-48 Condensation of nitriles (Thorpe)
- 9-33 Dimerization of cyano carbonyl compounds

Cyanohydrins (*see* Hydroxy Nitriles)

Cycloalkanes and Alkenes (*see* Alicyclic Compounds)

Aldehydes (*see* Dicarbonyl Compounds)

Diazo Compounds

0-112 Reaction between acyl halides and diazomethane

2-9 Reaction of active hydrogen compounds with tosyl azide

2-49 Diazotization of α -amino esters and similar compounds

6-41 Addition of diazo esters to aldehydes

7-45 Elimination from N-nitroso-N-alkyl compounds

9-6 Oxidation of hydrazones

Diazonium Salts

1-5 Direct diazotization of aromatic rings

2-49 Diazotization of primary amines

1,2-Dicarbonyl Compounds

0-103 Dicarbonylation of halides

0-106 Dimerization of acyl halides

0-109 Acylation of 1,3-dithianes, followed by hydrolysis

6-29 Addition of RLi and CO to carboxylic esters

6-69 Reaction of metalated aldimines with CO₂

9-9 Ozonization of alkynes or aromatic rings

9-16 Oxidation of ketones with selenium dioxide

9-21 Oxidative cleavage of α -amino ketones

9-23 Oxidation of olefins

9-27 Oxidation of alkynes

9-65 Reductive condensation of aromatic carboxylic acids

1,3-Dicarbonyl Compounds

0-94 Alkylation at a carbon bearing an active hydrogen

0-107 Acylation at a carbon bearing an active hydrogen

0-108 Acylation of carboxylic esters by carboxylic esters (Claisen; Dieckmann)

0-109 Acylation of ketones by carboxylic esters

0-110 Acylation of carboxylic acid salts

1-22 Reaction between aromatic compounds and diethyl oxomalonate

2-15 Acylation of acetals or ketals followed by hydrolysis

2-16 Alkoxyacetylalkylation of aldehydes

2-19 Acylation of enamines followed by hydrolysis (Stork)

3-14 Arylation at a carbon bearing an active hydrogen

5-2 Cleavage of activated olefins with water

5-17 Addition of active hydrogen compounds to olefins (Michael)

5-22 Free-radical addition of 1,3-dicarbonyl compounds to olefins

6-30 Reaction between nitriles, zinc, and α -halo esters (Blaise)

6-41 Addition of 1,3-dicarbonyl compounds to aldehydes or ketones (Knoevenagel)

6-43 Carboxylation of ketones and carboxylic esters

7-20 Cleavage of Michael adducts

7-50 Extrusion of sulfur from β -keto thiol esters

8-2 Rearrangement of epoxy ketones

8-9 Reaction of ketones with ethyl diazoacetate

9-16 Remote oxidation of ketones

9-33 Dimerization of β -keto esters or similar compounds

1,4-Dicarbonyl Compounds

0-6 Cleavage of furans

1-14 Acylation of aromatic rings by succinic anhydride

4-16 Coupling of ketones, carboxylic acids, and esters

5-21 Acylation of unsaturated ketones or alkynes

5-54 Dicarbalkoxylation of olefins and acetylenes

9-16 Remote oxidation of ketones

9-34 Dimerization of silyl enol ethers or of lithium enolates

1,5-Dicarbonyl Compounds

5-17 Addition of silyl enol ethers or silyl ketene acetals to unsaturated ketones or esters

Dicarboxylic Acids (*see* Dicarboxylic Compounds, Carboxylic Acids)

Dicyano Compounds

- 0-94 Alkylation of malononitriles
- 3-14 Arylation of malononitriles
- 5-17 Addition of nitriles to unsaturated nitriles (Michael)
- 5-25 Addition of HCN to triple bonds
- 6-41 Addition of malononitriles to aldehydes or ketones (Knoevenagel)
- 6-51 Addition of HCN to nitriles
- 9-10 Oxidation of *o*-diamines

Diesters (*see* Dicarboxylic Compounds)

Dihalides and Polyhalides

- 0-69 Treatment of epoxides with SOCl_2 , Ph_3P and CCl_4 or Ph_3PCl_2
- 0-76 Reduction of trihalides
- 0-87 Coupling of halides with trihalides
- 2-40 Decarboxylation of trihalo acids
- 2-44 The haloform reaction
- 3-17 Vicarious substitution of aryl nitro compounds
- 4-1 Free-radical halogenation
- 5-1 Addition of hydrogen halides to alkynes
- 5-26 Addition of halogens to olefins or alkynes
- 5-33 Free-radical addition of polyhalides to olefins
- 6-24 Reaction of PCl_5 , SF_4 , or other reagents with aldehydes, ketones, or other $\text{C}=\text{O}$ compounds
- 9-21 Treatment of amines with CuX and alkyl nitrites

Diketones (*see* Dicarboxylic Compounds)

Dinitro Compounds

- 4-13 Nitration of alkanes or nitro compounds
- 5-40 Addition of N_2O_4 to olefins

gem-Diols (Hydrates)

- 6-1 Hydration of aldehydes

1,2-Diols

- 0-7 Hydrolysis of epoxides
- 4-16 Coupling of alcohols
- 5-35 Hydroxylation of olefins

- 6-29 Addition of a masked Grignard reagent to an aldehyde or ketone

- 6-41 From aromatic aldehydes and carbanions

- 9-62 Bimolecular reduction of aldehydes or ketones

1,3-Diols

- 6-46 Condensation between formaldehyde and aldehydes or ketones (Tollens)

- 6-53 Addition of aldehydes to olefins (Prins)

Disulfides

- 0-38 Reaction between alkyl halides and disulfide ion

- 3-5 Reaction between aryl halides and disulfide ion

- 3-28 The Smiles rearrangement

- 5-28 Addition of ArSSCl to alkenes

- 9-35 Oxidation of thiols

- 9-54 Reduction of sulfonyl halides

Dithioacetals

- 0-36 From *gem*-dihalides or acetals and thiolate ions

- 5-6 Addition of thiols to alkynes

- 6-11 Addition of thiols to aldehydes or ketones

Dithiols

- 5-38 Reaction of alkenes with a disulfide and BF_3 etherate

- 6-11 Addition of H_2S to carbonyl compounds or imines

Enamines

- 0-97 Alkylation of enamines

- 5-7 Addition of amines to triple-bond compounds

- 6-14 Addition of amines to aldehydes or ketones

- 6-32 Reaction between Grignard reagents and formamides

- 6-47 Reaction of phosphonates with aldehydes or ketones

- 7-18 Dehydrocyanation of cyano amines

- 9-2 Dehydrogenation of tertiary amines

Enolate Ions

- 0-95 From enol acetates
- 2-3 Treatment of aldehydes or ketones with base
- 2-22 Treatment of active hydrogen compounds with base

Enol Carbamates

- 5-5 Reaction between alkynes, CO, and an amine

Enol Ethers and Esters

- 0-15 O-Alkylation of carbonyl compounds with diazo alkanes
- 0-17 Transesterification
- 0-20 Reaction between acyl halides and active hydrogen compounds
- 0-23 Transesterification
- 0-24 Acylation of vinylic halides
- 0-94 Alkylation with ortho esters
- 0-107 O-Acylation of 1,3-dicarbonyl compounds
- 5-4 Addition of alcohols or phenols to alkynes; addition of aldehydes or ketones to ketene
- 5-5 Addition of carboxylic acids to alkynes
- 6-6 Addition of alcohols or anhydrides to aldehydes or ketones
- 6-33 Reaction between carboxylic esters and Tebbe's reagent or metal carbene complexes
- 6-47 Reaction of α -alkoxy phosphoranes with aldehydes or ketones
- 7-2 Cleavage of acetals
- 7-31 Elimination from β -halo acetals

Enols (*see* Unsaturated Alcohols and Phenols)

Enol Thioethers

- 5-6 Addition of thiols to alkynes
- 6-11 Reaction of aldehydes or ketones with thiols
- 9-2 Dehydrogenation and reduction of sulfoxides

Enynes

- 5-15 Dimerization of alkynes

Episulfides

- 0-36 Reaction between epoxides and phosphine sulfides
- 5-28 Cyclization of β -halo disulfides
- 6-62 Reaction of diazoalkanes with sulfur or thioketones

Epoxides

- 0-13 Cyclization of halohydrins
- 0-16 Cyclization of 1,2-diols
- 0-18 Payne rearrangement of 2,3-epoxy alcohols
- 4-8 Epoxidation of a secododecahedrane
- 5-36 Epoxidation of olefins
- 6-29 Reaction of carbonyl compounds with *gem*-dihalides and Li or BuLi
- 6-45 Condensation between aldehydes and α -halo esters, ketones, or amides (Darzens)
- 6-61 Addition of sulfur ylides or diazomethane to aldehydes or ketones
- 9-63 Bimolecular reduction of aldehydes or ketones

Esters (*see* Carboxylic Esters, Inorganic Esters)

Ethers (*see also* Hydroxy Ethers, etc.)

- 0-6 Cleavage of oxonium ions
- 0-10 Reaction between carboxylic esters and alkoxide ion
- 0-12 Reaction between alkoxides or aroxides and alkyl halides (Williamson)
- 0-14 Reaction between alkoxides or aroxides and inorganic esters
- 0-15 Alkylation of alcohols or phenols with diazo compounds
- 0-16 Dehydration of alcohols
- 0-17 Transesterification
- 0-19 Alkylation of alcohols with onium salts
- 0-29 Exchange of ethers and oxonium salts
- 0-30 Reaction of halides with oxide ion
- 0-68 Cleavage of oxonium salts
- 0-79 Reduction of acetals or ketals
- 0-92 Reaction between Grignard reagents and acetals or ketals; dimerization of acetals

Ethers (continued)

- 2-23** Reaction between Grignard reagents and *t*-butyl peresters
3-4 Reaction between aryl halides and alkoxides or aroxides
4-8 Cyclization of alcohols with lead tetraacetate
4-36 Desulfurization of thiono esters
5-4 Addition of alcohols or phenols to olefins
5-22 Free-radical addition of ethers to olefins
6-7 Reductive alkylation of alcohols
9-40 Reduction of carboxylic esters
9-60 Reduction of peroxides

Glycidic Esters

- 5-36** Epoxidation of α,β -unsaturated esters
6-45 Condensation between aldehydes or ketones and α -halo esters (Darzens)

Grignard Reagents (*see* Organometallic Compounds)Halo Acids, Esters, Aldehydes, Ketones (*see* Halo Carbonyl Compounds)

Haloamines

- 5-29** Addition of N-haloamines to unsaturated compounds

N-Haloamines and Amides

- 2-54** Halogenation of amines or amides

Halo Carbonyl Compounds

- 0-69** Reaction of acyl chlorides with ethylene oxide and NaI
0-71 Reaction of diazo ketones with hydrohalic acids
2-4 Halogenation of aldehydes or ketones
2-5 Halogenation of carboxylic acids (Hell-Volhard-Zelinskii) and acid derivatives
5-26 Addition of halogens to ketenes
5-27 Addition of HOBr or HOCl to triple bonds; addition of chlorine acetate or other reagents to olefins
5-34 Addition of acyl halides to olefins
8-10 Rearrangement of halo epoxides
9-23 Oxidation of certain alkenes

Halo Ethers and Acetals

- 5-27** Addition of hypohalites to double bonds
6-23 Addition of alcohols and hydrogen halides to aldehydes or ketones
6-24 Reaction of carboxylic esters with ClF or other reagents

Haloformic Esters

- 0-20** Alcoholysis of phosgene

Halohydrins

- 0-69** Cleavage of epoxides with hydrogen halides
5-27 Addition of hypohalous acids to olefins

Halo Sulfides, Sulfoxides, and Sulfones

- 2-6** Halogenation of sulfoxides and sulfones
5-29 Addition of sulfonyl halides to olefins
9-71 Pummerer rearrangements

Hemiacetals

- 4-4** Electrolytic oxidation of tetrahydrofuran
6-6 Addition of alcohols to aldehydes or ketones

Hemiaminals

- 6-13** Reaction between aldehydes or ketones and ammonia
6-14 Reaction between aldehydes or ketones and amines

Hemimercaptals

- 6-11** Addition of thiols to aldehydes or ketones

Heterocyclic Compounds (*see also* Anhydrides, Aziridines, Epoxides, Episulfides, Imides, Lactams, Lactones)

- 0-13** Cyclization of halohydrins (cyclic ethers)
0-16 Cyclization of glycols (cyclic ethers; furans)
0-17 Reaction of diols with acetals (cyclic acetals)
0-36 Reaction of dihalides with sulfide ion (cyclic sulfides)

Heterocyclic Compounds (continued)

- 0-43** Cyclization of haloamines (cyclic amines); dealkylation of quaternary salts of nitrogen heterocycles
- 0-45** Reaction between dihalides and cyanamide (cyclic amines)
- 0-59** Reaction between ureas and malonic esters (cyclic ureides)
- 1-9** Sulfurization of aromatic rings (cyclic sulfides)
- 1-14** Intramolecular acylation
- 1-21** Intramolecular amidation of aromatic rings
- 1-23** Cyclization of amides with POCl_3 (isoquinolines)
- 2-12** Intramolecular nitrene insertion
- 3-6** Intramolecular arylation of amines (cyclic amines)
- 3-14** Intramolecular arylation of active hydrogen compounds
- 3-17** Arylation of heterocyclic nitrogen compounds
- 3-18** Amination of heterocyclic nitrogen compounds
- 4-8** Cyclization of alcohols with lead tetraacetate (tetrahydrofurans)
- 4-15** Cyclization of N-tosyl malonic esters
- 4-18** Intramolecular arylation (Pschorr)
- 4-23** Alkylation, arylation, and carbalkoxylation of nitrogen heterocycles
- 5-7** Addition of ammonia or primary amines to conjugated dienes (pyrroles)
- 5-10** Hydrogenation of heterocyclic aromatic rings
- 5-12** Addition of boranes to dienes (cyclic boranes)
- 5-37** Photooxidation of dienes (cyclic peroxides)
- 5-38** Cyclization of unsaturated alcohols with sulfonyl chlorides (tetrahydrofurans)
- 5-42** Addition of aminonitrenes to triple bonds (1-azirines)
- 5-46** 1,3-Dipolar addition to double or triple bonds
- 5-47** Diels-Alder addition involving hetero atoms
- 5-50** Expansion of heterocyclic rings upon treatment with carbenes
- 5-52** Other cycloaddition reactions
- 6-6** Formation of cyclic acetals; reaction between diketones and acids (furans, pyrans)
- 6-11** Addition of H_2S to aldehydes or ketones (cyclic thioacetals)
- 6-13** Reaction between aldehydes and ammonia (cyclic amines)
- 6-14** Intramolecular addition of amines to carbonyl groups (cyclic imines)
- 6-18** Reaction of dinitriles with ammonia (cyclic imidines)
- 6-20** Reaction between hydrazines and β -diketones or β -keto esters (pyrazoles; pyrazolones)
- 6-38** Ring expansion of thiono lactones (cyclic ethers)
- 6-41** Reaction of ketones with tosylmethylisocyanide (oxazolines)
- 6-53** Reaction between alcohols and aldehydes (dioxanes)
- 6-57** Trimerization of aldehydes (trioxanes)
- 6-60** Trimerization of nitriles (triazines)
- 6-63** Addition of olefins to aldehydes or ketones (oxetanes)
- 7-25** Reaction of dichlorobenzyl sulfones with base (thiiren-1,1-dioxides)
- 7-47** Extrusion of CO_2 from benzoxadiazepinones (indazoles)
- 7-51** Condensation of thiobenzilic acid with aldehydes or ketones (oxathiolan-5-ones)
- 8-15** Curtius rearrangement of cycloalkyl or aryl azides
- 8-19** Rearrangement of N-haloamines (cyclic amines)
- 8-22** Ring enlargement of cyclic quaternary ammonium salts (cyclic amines)
- 8-33** Ring expansion of N-acylaziridines (oxazoles)
- 8-36** Cyclization of arylhydrazones (Fischer indole synthesis)
- 8-42** Acid-catalyzed rearrangement of N-haloamines (pyrrolidines; piperidines—Hofmann-Löffler)
- 9-1** Aromatization of heterocyclic rings
- 9-37** Reduction of α,β -unsaturated ketones (pyrazolones)
- 9-39** Reduction of lactams (cyclic amines)
- 9-40** Reduction of lactones (cyclic ethers)

Hydrates (*see gem-Diols*)**Hydrazides**

0-52 Acylation of hydrazines with acyl halides

0-55 Acylation of hydrazines with carboxylic esters

Hydrazines

3-18 Hydrazination of heterocyclic nitrogen compounds

5-7 Addition of hydrazines to olefins

8-14 Reaction between ureas and NaOBr (Hofmann)

9-47 Reduction of N-nitro compounds

9-50 Reduction of N-nitroso compounds

9-53 Reduction of azo compounds or diazonium salts

9-68 Reduction of nitro compounds

Hydrazo Compounds (*see Hydrazines*)**Hydrazones**

2-7 Aliphatic diazonium coupling

6-20 Addition of hydrazines to aldehydes or ketones

Hydroperoxides

0-31 Reaction between alkyl or acyl halides and hydrogen peroxide

2-25 Reaction between organometallic reagents and oxygen

4-9 Autoxidation; reaction of alkenes with singlet oxygen

Hydroxamic Acids

0-52 Acylation of hydroxylamine with acyl halides

0-55 Acylation of hydroxylamine with carboxylic esters

6-4 Hydrolysis of aliphatic nitro compounds

Hydroxy Acids

0-10 Hydrolysis of lactones

0-103 Dicarboxylation of aryl iodides

1-20 Carboxylation of phenols

1-22 Reaction between aromatic compounds and diethyl oxomalonate

2-25 Oxidation of dilithiated carboxylic acids

6-5 Hydrolysis of cyanohydrins

6-30 Reaction between aldehydes or ketones and zinc carboxylates

6-41 Addition of dianions of carboxylic acids to ketones

6-52 Addition of CO₂ to aldehydes and ketones

8-6 Rearrangement of benzils

8-7 Rearrangement of α,β -epoxy ketones (Favorskii)

9-69 Reaction between keto aldehydes and base

Hydroxy Aldehydes and Ketones

0-5 Hydrolysis of diazo ketones

0-97 Reaction between dithiane salts and epoxides

0-98 Alkylation of oxazines with epoxides

1-30 Rearrangement of phenolic esters (Fries)

2-19 Alkylation of enamines with epoxides

4-4 Hydroxylation of ketones

6-25 Monoreduction of α -diketones

6-29 Addition of RLi and CO to ketones

6-30 Reaction between aldehydes or ketones, zinc, and halo ketones

6-39 Combination of aldehydes and/or ketones (aldol)

6-41 Various Knoevenagel methods

6-46 Condensation of formaldehyde with aldehydes or ketones (Tollens)

6-54 Condensation of aromatic aldehydes (benzoin)

6-69 Reaction of metalated aldimines with aldehydes or epoxides

8-2 Rearrangement of epoxy silyl ethers

8-4 Rearrangement of α -hydroxy aldehydes or ketones

9-20 Oxidation of epoxides

9-23 Oxidation of alkenes

9-65 Condensation of carboxylic esters (acyloin)

Hydroxamines and Amides

0-49 Amination of epoxides

0-51 Hydrolysis of silyloxy isocyanides

1-22 Hydroxymethylation of aromatic amines

1-25 Aminoalkylation and amidoalkylation of phenols

Hydroxyamines and Amides (continued)

- 1-29** Hydroxylation of amines
- 3-27** Rearrangement of aryl hydroxylamines (Bamberger)
- 4-4** Hydroxylation of amides
- 5-39** Oxyamination of double bonds; aminomercuration of alkenes, followed by hydrolysis
- 6-13** Addition of ammonia to aldehydes or ketones
- 6-14** Addition of amines or amides to aldehydes or ketones
- 6-30** Reaction between aldehydes or ketones, zinc, and halo amides
- 6-41** Reaction of aldehydes with the conjugate base of formamide; reaction of ketones with imines
- 6-67** Reaction between isocyanides, TiCl_4 and aldehydes or ketones, followed by hydrolysis
- 9-62** Coupling of ketones and O-methyl oximes

Hydroxy Esters

- 0-23** Transesterification of lactones
- 0-25** Acylation of epoxides
- 4-4** Hydroxylation of carboxylic esters
- 6-30** Reaction between aldehydes or ketones, zinc, and α -halo esters (Reformatsky)
- 6-40** Condensation between carboxylic esters and aldehydes or ketones
- 6-41** Addition of α -metalated esters to ketones

Hydroxy Ethers

- 0-18** Alcoholysis of epoxides

Hydroxylamines

- 5-7** Addition of hydroxylamine to olefins
- 6-26** Reduction of oximes
- 6-35** Addition of alkyllithium compounds to oximes
- 7-8** Cleavage of amine oxides (Cope)
- 8-22** Rearrangement of N-oxides (Meisenheimer)
- 9-24** Oxidation of amines
- 9-49** Reduction of nitro compounds

Hydroxy Nitriles

- 0-101** Reaction between epoxides and cyanide ion
- 4-4** Hydroxylation of nitriles
- 6-30** Reaction between aldehydes and ketones, zinc, and halo nitriles
- 6-41** Addition of nitriles to ketones
- 6-49** Addition of HCN to aldehydes or ketones

Hydroxy Sulfonic Acids

- 0-41** Reaction between epoxides and bisulfite ion
- 6-12** Addition of bisulfite ion to aldehydes or ketones

Hydroxy Thiols and Thioethers

- 0-35** Reaction between epoxides and NaSH
- 0-36** Reaction between epoxides and thiolate ions
- 1-26** Thioalkylation of phenols
- 5-38** Hydroxysulfenylation of alkenes
- 6-11** Addition of H_2S to aldehydes or ketones

Imides (including Ureides)

- 0-52** Reaction between acyl halides and lithium nitride
- 0-53** Amination of anhydrides
- 0-58** N-Alkylation of imides
- 0-59** N-Acylation of amides or imides
- 5-7** Addition of imides to olefins
- 5-23** Hydrocarboxylation of unsaturated amides
- 6-68** Addition of N-halo amides to isocyanides
- 8-14** Reaction between amides and NaOBr (Hofmann)
- 8-15** Rearrangement of acyl azides in the presence of water (Curtius)
- 9-18** Oxidation of lactams

Imines

- 2-8** Reaction between active hydrogen compounds and nitroso compounds
- 2-19** Treatment of enamines with nitrilium salts
- 5-7** Addition of amines to triple-bond compounds

Imines (continued)

- 6-13** Addition of ammonia to aldehydes or ketones
6-14 Addition of amines to aldehydes or ketones
6-37 Addition of Grignard reagents to nitriles
6-47 Addition of ylides to nitroso compounds
6-69 Reaction of isocyanides with organometallic compounds (metalated imines)
8-15 Pyrolysis of alkyl or aryl azides
8-18 Reaction between oxime sulfonates and organometallic compounds
8-19 Rearrangement of trityl N-haloamines and hydroxylamines (Stieglitz)
9-5 Dehydrogenation of secondary amines
9-51 Reduction of oximes

Imino Esters (Imidates), Imino Thioesters, and Their Salts

- 1-27** Reaction of phenols with nitriles
6-9 Alcoholysis of nitriles (Pinner)
8-18 Reaction between oxime sulfonates and organoaluminum sulfides
8-44 From amides

Imino Nitriles

- 8-18** Reaction between an oxime sulfonate, an organoaluminum compound, and Me_3SiCN

Inorganic Esters

- 0-32** Reaction of alcohols or alkyl halides with inorganic acids or halides
2-28 Oxidation of trialkylboranes
3-8 Reaction between aryl halides and POCl_3
3-20 Reaction between diazonium salts and $\text{F}_3\text{CSO}_2\text{OH}$
5-27 Addition of Cl_2 and SO_3 to alkenes
5-40 Addition of N_2O_4 to alkenes (nitro nitrites, nitro nitrates)

Isocyanates

- 0-52** Reaction between amines and phosphine
0-59 Reaction between oxalyl chloride and unsubstituted amides

- 0-62** Alkylation or acylation of cyanate ion
2-55 Carbonylation of amines
5-32 Addition of iodine isocyanate to double bonds
8-14 Reaction between amides and NaOBr (Hofmann)
8-15 Rearrangement of acyl azides (Curtius)
8-16 Rearrangement of hydroxamic acids (Lossen)
8-17 Addition of hydrazoic acid to carboxylic acids (Schmidt)
9-30 Oxidation of isocyanides

Isocyanides

- 0-51** Reaction between primary amines and chloroform, or Me_3SiCN and epoxides or oxetanes
0-101 Reaction between alkyl halides and cyanide ion
7-41 Elimination of water from N-alkylformamides
9-55 Reduction of isocyanates

Isothiocyanates

- 0-52** Reaction between amines and thiophosgene
0-62 Alkylation or acylation of thiocyanate ion
3-21 Reaction between diazonium salts and thiocyanate ion
6-19 Addition of amines to carbon disulfide
9-30 From isocyanides

Isothiuronium Salts

- 0-35** Reaction between alkyl halides and thiourea

Ketals (see Acetals)**Ketenes**

- 7-1** Pyrolysis of carboxylic acids
7-14 Dehydrohalogenation of acyl halides
7-30 Dehalogenation of α -halo acyl halides
8-8 Rearrangement of diazo ketones (Wolff)

Ketenimines

- 6-47** Reaction between phosphoranes and isocyanates
7-1 Dehydration of amides

Keto Acids, Aldehydes, and Esters (*see* Dicarboxyl Compounds)**Ketones** (*see also* Dicarboxyl Compounds, Unsaturated Carbonyl Compounds, etc.)

- 0-1** Hydrolysis of vinylic halides
0-2 Hydrolysis of *gem*-dihalides
0-4 Hydrolysis of enol esters of inorganic acids
0-6 Hydrolysis of enol ethers, ketals, thioketals, etc.
0-10 Hydrolysis of enol esters
0-76 Reduction of halo ketones
0-78 Reduction of hydroxy ketones
0-82 Reduction of diazo ketones or nitro ketones
0-87 Coupling of halo ketones with lithium alkylcopper reagents
0-94 Acetoacetic ester synthesis and similar reactions
0-95 Alkylation of ketones
0-97 Alkylation and hydrolysis of dithianes and similar compounds
0-98 Alkylation and hydrolysis of oxazines
0-99 Reaction of halo ketones or diazo ketones with boranes
0-102 Carbonylation of alkyl halides
0-104 Reaction between acyl halides and organometallic compounds
0-105 Reaction between other acid derivatives and organometallic compounds
0-107 Acylation of active hydrogen compounds followed by cleavage
0-109 Reduction of β -keto sulfoxides
0-110 Acylation of carboxylic acid salts followed by cleavage
0-113 Ketonic decarboxylation
1-14 Acylation of aromatic rings (Friedel-Crafts)
1-19 Reaction between aromatic rings and phosgene
1-27 Acylation of aromatic rings with nitriles (Hoesch)

- 1-30** Rearrangement of phenolic ethers (Fries)
1-36 Photolysis of acylated arylamines
2-2 Rearrangement of hydroxy olefins
2-16 Reaction between aldehydes and boron-stabilized carbanions
2-19 Alkylation of enamines followed by hydrolysis (Stork)
2-25 Oxidation of *gem*-dimetallic compounds
2-32 Carbonylation of organometallic compounds
2-40 Decarboxylation of β -keto acids or esters
2-41 Cleavage of tertiary alkoxides
2-42 Reaction between amino acids and anhydrides (Dakin-West)
2-43 Basic cleavage of β -diketones
3-14 Arylation of ketones
3-15 Acylation of aryl iodides
4-20 Arylation of allylic alcohols
4-23 Acylation of nitrogen heterocycles
4-31 Reaction of diazonium salts with oximes, followed by hydrolysis; or with R_4Sn and CO; or with silyl enol ethers
5-3 Hydration of alkynes or allenes
5-9 Selective reduction of unsaturated ketones
5-10 Reduction of phenols
5-12 Oxidation of boranes; hydrolysis of unsaturated boranes
5-17 Addition of ketones to activated olefins (Michael)
5-18 Addition of organometallic compounds to unsaturated ketones
5-19 Addition of boranes to unsaturated ketones
5-20 Addition of tin and mercury hydrides to unsaturated ketones
5-22 Free-radical addition of aldehydes or ketones to olefins
5-24 Hydroacylation of alkenes
5-50 Hydrolysis of bicyclo[4.1.0]heptanes
6-2 Hydrolysis of imines, oximes, hydrazones, and other $C=N$ compounds
6-4 Hydrolysis of secondary aliphatic nitro compounds (Nef)
6-31 Reaction between lithium carboxylates and alkyllithium compounds

Ketones (continued)

- 6-33 Indirectly, from carboxylic esters
 6-37 Addition of Grignard reagents to nitriles
 6-42 Hydrolysis of epoxy silanes
 6-69 Reaction of alkyl halides with metalated aldimines
 7-1 Dehydration of 1,2-diols
 7-32 Fragmentation of γ -amino or γ -hydroxy halides
 7-33 Fragmentation of 1,3-diols
 7-38 Fragmentation of certain ketoximes
 7-43 Pyrolysis of β -hydroxy olefins
 7-44 Pyrolysis of allylic ethers
 8-2 Rearrangement of glycols and related compounds (pinacol)
 8-3 Ring expansion of certain hydroxyamines (Tiffeneu-Demyanov)
 8-4 Acid-catalyzed ketone rearrangements
 8-9 Homologation of aldehydes or ketones
 8-14 Reaction between α -hydroxy or α -halo amides and NaOBr (Hofmann)
 8-21 Cleavage of hydroperoxides
 8-25 Treatment of boranes with CO and H₂O, followed by NaOH and H₂O₂; or with CN⁻ followed by trifluoroacetic anhydride; from dialkylchloroboranes
 8-28 Treatment of lithium alkynyltrialkylborates with electrophiles
 8-32 [1,3] Sigmatropic rearrangements of allylic vinylic ethers
 9-3 Oxidation of secondary alcohols
 9-7 Oxidative cleavage of glycols and related compounds
 9-9 Ozonolysis of olefins
 9-10 Oxidative cleavage of olefins
 9-11 Oxidation of diarylmethanes
 9-14 Bisdecarboxylation of malonic acids
 9-15 Oxidative decyanation of nitriles
 9-16 Oxidation of activated or unactivated methylene groups
 9-20 Oxidation of secondary alkyl halides and tosylates
 9-21 Oxidation of amines or nitro compounds
 9-23 Oxidation of olefins with noble-metal salts
 9-37 Reduction of diketones or quinones

- 9-57 Indirect oxidative decyanation of nitriles

Lactams

- 0-54 Cyclization of amino acids
 0-55 Reaction between lactones and ammonia or amines; ring expansion of lactams
 0-58 Cyclization of halo amides
 5-7 Addition of lactams to olefins
 5-23 Hydrocarboxylation of unsaturated amines
 6-31 Reaction between imines, zinc, and halo esters
 6-47 Reaction between imides and phosphoranes
 6-64 Addition of ketenes to imines; addition of enamines to isocyanates
 8-17 Reaction between cyclic ketones and hydrazoic acid (Schmidt)
 8-18 Rearrangement of oximes of cyclic ketones (Beckmann)
 8-19 Expansion of aminocyclopropanols
 9-18 Oxidation of cyclic tertiary amines

Lactones

- 0-22 Cyclization of hydroxy acids
 0-24 Cyclization of halo acids
 0-89 Intramolecular coupling
 2-43 Cleavage of cyclic α -cyano ketones
 5-4 Internal addition of alcohols to a ketene function
 5-5 Cyclization of olefinic acids
 5-23 Hydrocarboxylation of unsaturated alcohols
 5-27 Halolactonization
 5-45 Reaction of alkenes with manganese(III) acetate
 6-47 Reaction of anhydrides with phosphoranes
 6-63 Addition of ketenes to aldehydes or ketones
 7-47 Extrusion of CO₂ from 1,2-dioxolane-3,5-diones
 7-49 Decarboxylation of cyclic peroxides (Story)
 8-20 Reaction between cyclic ketones and peroxy compounds (Baeyer-Villiger)
 8-42 Rearrangement of N-halo amides
 9-18 Oxidation of cyclic ethers

Lactones (continued)

- 9-22 Oxidation of diols
- 9-41 Reduction of cyclic anhydrides
- 9-69 Oxidative-reductive ring closure of dialdehydes

Mercaptals (see Thioacetals)

Mercaptans (see Thiols)

Metalloenes

- 2-35 Reaction between sodium cyclopentadienylide and metal halides

Monoesters of Dicarboxylic Acids

- 0-21 Alcoholysis of cyclic anhydrides
- 0-23 Equilibration of dicarboxylic acids and esters
- 6-9 Alcoholysis of cyano acids
- 9-10 Oxidative cleavage of catechols

Nitrile Oxides

- 7-40 Oxidation of nitro compounds

Nitriles (see also Dicyano Compounds, Cyano Carbonyl Compounds, etc.)

- 0-95 Alkylation of nitriles
- 0-99 Reaction of halo nitriles or diazo nitriles with boranes
- 0-101 Reaction between alkyl halides and cyanide ion
- 1-28 Cyanation of aromatic rings
- 2-17 Cyanation of ketones, nitro compounds, or benzylic compounds
- 2-33 Cyanation of organometallic compounds
- 2-40 Decarboxylation of α -cyano acids
- 3-11 Reaction between aryl halides and CuCN (Rosenmund-von Braun)
- 3-12 Cyanide fusion of sulfonic acid salts
- 3-14 Arylation of nitriles
- 3-17 Vicarious substitution of aryl nitro compounds
- 4-28 Reaction between diazonium salts and CuCN (Sandmeyer)
- 4-39 Reaction of acyl peroxides with copper cyanide
- 4-41 Decarbonylation of aromatic acyl cyanides
- 5-17 Addition to activated olefins (Michael)
- 5-19 Addition of boranes to acrylonitrile

- 5-20 Addition of tin and mercury hydrides to unsaturated nitriles
- 5-22 Free-radical addition of nitriles to olefins
- 5-25 Addition of HCN to olefins
- 5-43 Addition of CN and SR to double bonds
- 6-22 From aldehydes or carboxylic esters
- 6-41 Reaction of ketones with tosylmethylisocyanide
- 6-51 Addition of KCN to sulfonyl hydrazones
- 6-59 Reaction between acid salts and BrCN
- 7-37 Dehydration of aldoximes and similar compounds
- 7-38 Fragmentation of ketoximes
- 7-39 Dehydration of amides
- 7-40 From primary nitro compounds or azides
- 8-22 Rearrangement of isocyanides
- 9-5 Dehydrogenation of amines
- 9-6 Oxidation of hydrazones
- 9-13 Treatment of carboxylic acids with trifluoroacetic anhydride and NaNO_2
- 9-55 Reduction of nitrile oxides
- 9-58 Reduction of nitro compounds with NaBH_2S_3

Nitro Compounds

- 0-60 Reaction between alkyl halides and nitrite ion
- 0-94 Alkylation of nitro compounds
- 1-2 Nitration of aromatic rings
- 1-32 Rearrangement of N-nitro aromatic amines
- 2-40 Decarboxylation of α -nitro acids
- 2-51 N-Nitration of amines or amides
- 3-17 Alkylation of aromatic nitro compounds
- 4-13 Nitration of alkanes
- 4-26 Reaction between diazonium salts and sodium nitrite
- 5-7 Nitromercuration-reduction of alkenes
- 5-9 Reduction of unsaturated nitro compounds
- 5-17 Addition to activated olefins (Michael)

Nitro Compounds (continued)

- 5-18** Addition of organometallic reagents to nitroolefins
5-30 Addition of NOCl and other nitrogen compounds to olefins
5-40 Addition of N₂O₄ and other nitrogen compounds to olefins
5-43 Addition of NO₂ and SR to double bonds
6-41 Addition of nitro compounds to aldehydes or ketones; reaction of pyrylium salts with nitromethane
6-43 Carboxylation of nitro compounds
9-25 Oxidation of primary amines, oximes, azides, isocyanates, or nitroso compounds

Nitrogen Ylides

- 2-21** Treatment of quaternary ammonium salts with organometallic compounds

Nitrones

- 0-34** Alkylation of oximes

Nitroso Compounds

- 1-3** Nitrosation of aromatic rings
1-33 Rearrangement of N-nitroso aromatic amines (Fischer-Hepp)
1-39 Nitrosative decarboxylation of aromatic acids
2-8 Nitrosation at a carbon bearing an active hydrogen
2-51 Reaction between secondary amines or amides and nitrous acid
5-30 Addition of NOCl to olefins
8-42 Photolysis of nitrites (Barton)
9-6 Oxidation of hydroxylamines
9-24 Oxidation of primary amines
9-48 Reduction of nitro compounds

Olefins (see Alkenes)**Organometallic Compounds (see also Boranes)**

- 1-39** Replacement of aromatic COOH with Hg
2-21 Metallation of susceptible positions with organometallic compounds
2-22 Metallation of susceptible positions with metals or strong bases

- 2-24** Cleavage of alkyl groups from di- or polyvalent organometallic compounds

- 2-34** Reaction between an organometallic compound and a metal

- 2-35** Reaction between an organometallic compound and a metal halide

- 2-36** Reaction between an organometallic compound and an organometallic compound (exchange)

- 2-38** Metallation of alkyl or aryl halides with metals

- 2-39** Metallation of alkyl or aryl halides with organometallic compounds

- 2-40** Decarboxylation of carboxylic acid salts

- 4-32** Reaction of diazonium salts with metals

- 4-37** Reaction between sulfides and lithium or lithium naphthalide

- 5-13** Hydrometallation of alkenes

- 5-18** Reaction between copper-containing compounds and organolithium compounds

- 5-53** Addition of allylic zinc compounds to vinylic Grignard and lithium reagents (*gem*-dimetallic compounds)

- 8-12** Rearrangement of Grignard reagents

Ortho Esters

- 0-12** Reaction of alkoxides with 1,1,1-trihalides (Williamson)

- 0-17** Transesterification

- 4-7** Electrolytic alkoxylation of acetals

- 6-6** Addition of alcohols to formic acid

Osazones

- 6-20** Addition of hydrazines to α -hydroxy aldehydes or ketones

Oxime Ethers

- 0-15** Alkylation of oximes with diazo compounds

- 0-34** Alkylation of oximes with alkyl sulfates

Oximes

- 2-8** Nitrosation at a carbon bearing an active hydrogen

- 5-30** Addition of NOCl to olefins

Oximes (continued)

- 6-21** Addition of hydroxylamine to aldehydes or ketones
6-35 Addition of Grignard reagents to the conjugate bases of nitro compounds
8-42 Photolysis of nitrites (Barton)
9-8 Cleavage of cyclic ketones with NOCl and an alcohol
9-24 Oxidation of aliphatic primary amines
9-58 Reduction of nitro compounds

Oxiranes (*see* Epoxides)**Oxonium Salts**

- 0-29** Reaction between alkyl halides and ethers or ketones

Ozonides

- 9-9** Ozonolysis of olefins

Peptides

- 0-54** Coupling of amino acids

PeroxiJes (*see also* Hydroperoxides, Peroxy acids)

- 0-31** Reaction of alkyl and acyl halides with peroxide ion
4-10 Reaction between hydroperoxides and susceptible hydrocarbons
5-4 Oxymercuration–reduction of alkenes in the presence of a hydroperoxide
5-37 Photooxidation of dienes
7-49 Reaction of ketones with H₂O₂

Peroxy Acids

- 9-32** Oxidation of carboxylic acids

Phenols

- 0-10** Hydrolysis of phenolic esters
0-32 Cleavage of phenolic ethers with sulfonic acids
0-36 Cleavage of phenolic ethers
0-46 Cleavage of phenolic ethers
0-68 Cleavage of phenolic ethers with HI or HBr
1-29 Electrophilic hydroxylation of aromatic rings
1-30 Rearrangement of phenolic esters (Fries)

- 1-31** Rearrangement of phenolic ethers
2-25 Oxidation of aryl organometallic compounds
2-26 Oxidation of arylthallium compounds
3-1 Hydrolysis of aryl halides and other compounds
3-2 Reaction between naphthylamines and bisulfite ion (Bucherer)
3-3 Alkali fusion of sulfonate ions
3-20 Hydrolysis of diazonium salts
3-27 Rearrangement of N-hydroxylamines
4-5 Free-radical hydroxylation of aromatic rings
4-21 Phenylation of phenols
5-50 Ortho methylation of phenols
6-25 Reduction of quinones
8-5 The dienone–phenol rearrangement
8-20 Cleavage of aryl ketones with peracids (Baeyer–Villiger)
8-21 Rearrangement of aralkyl peroxides
8-35 Rearrangement of allylic aryl ethers (Claisen)
8-45 Rearrangement of azoxy compounds (Wallach)
9-1 Aromatization of cyclic ketones
9-12 Oxidative cleavage of alkylbenzenes or aromatic aldehydes
9-42 Reduction of phenolic esters
9-43 Reduction of certain acids and esters

Phosphines

- 0-43** Reaction between alkyl halides and phosphine
0-82 Reduction of quaternary phosphonium salts
2-35 Reaction between phosphorus halides and Grignard reagents

Phosphonates

- 6-47** Reaction between alkyl halides and phosphites (Arbuzov)

Phosphoranes

- 6-47** Treatment of phosphonium ions with alkylolithiums

Quaternary Ammonium and Phosphonium Salts

- 0-43** Alkylation of amines (Menschutkin) or phosphines

Quaternary Ammonium and Phosphonium Salts (continued)

- 5-7** Addition of tertiary amines to alkenes
6-47 Reaction of phosphines with Michael olefins or with alkyl halides

Quinones

- 1-14** Intramolecular Friedel-Crafts acylation of diaryl ketones
9-4 Oxidation of phenols or aromatic amines
9-19 Oxidation of aromatic hydrocarbons

Schiff Bases (*see* Imines)

Selenides

- 0-36** Selenylation of alkyl halides
2-13 Selenylation of aldehydes, ketones, and carboxylic esters
2-29 Selenylation of organometallic compounds
9-56 Reduction of selenoxides

Semicarbazones

- 6-20** Addition of semicarbazide to aldehydes or ketones

Silyl Enol Ethers

- 2-23** Trialkylsilylation of ketones or aldehydes
2-27 Reaction between vinylic lithium compounds and silyl peroxides
5-18 Michael-type reaction in the presence of Me_3SiCl

Sulfenyl Chlorides

- 4-12** Chlorosulfenation

Sulfides (*see* Thioethers)

Sulfinic Acids and Esters

- 0-118** Reduction of sulfonyl chlorides
2-29 Reaction of Grignard reagents with SO_2
3-28 The Smiles rearrangement
4-27 Reaction of diazonium salts with FeSO_4 and Cu
7-12 Cleavage of sulfones

Sulfonamides

- 0-58** N-Alkylation of sulfonamides
0-94 Alkylation of sulfonamides
0-99 Reaction of halo sulfonamides with boranes
0-116 Reaction between sulfonyl halides and ammonia or amines
3-17 Vicarious substitution of aryl nitro compounds
5-7 Addition of sulfonamides to olefins
9-39 Reduction of acyl sulfonamides
9-53 Reduction of sulfonyl azides

Sulfones

- 0-40** Reaction between alkyl halides and sulfinates
0-94 Alkylation of sulfones
0-95 Alkylation of sulfones
0-99 Reaction of halo sulfones with boranes
0-109 Reaction between carboxylic esters and methylsulfonyl carbanion
0-119 Reaction between sulfonic acid derivatives and organometallic compounds
1-10 Sulfonylation of aromatic rings
3-5 Reaction between aryl halides and sulfinates ions
3-17 Vicarious substitution of aryl nitro compounds
5-17 Addition of sulfones to activated olefins (Michael)
5-18 Addition of organometallic compounds to unsaturated sulfones
5-28 Addition of sulfonyl halides to olefins
6-41 Addition of sulfones to aldehydes or ketones (Knoevenagel)
9-31 Oxidation of thioethers or sulfoxides

Sulfonic Acid Esters

- 0-32** Reaction between alcohols or ethers and sulfonic acids
0-94 Alkylation of sulfonic acid esters
0-95 Alkylation of sulfonic acid esters
0-99 Reaction of halo sulfonic acid esters with boranes
0-115 Alcoholysis of sulfonic acid derivatives
3-17 Vicarious substitution of aryl nitro compounds

Sulfonic Acid Esters (continued)

- 6-41** Addition of sulfonic acid esters to aldehydes or ketones (Knoevenagel)

Sulfonic Acids

- 0-41** Reaction between alkyl halides and sulfite ion
0-114 Hydrolysis of sulfonic acid derivatives
1-7 Sulfonation of aromatic rings
1-40 Sulfonation with rearrangement (Jacobsen)
2-14 Sulfonylation of aldehydes, ketones, or carboxylic acids
3-5 Reaction between aryl halides and sulfite ion
9-26 Oxidation of thiols or other sulfur compounds

Sulfonium Salts

- 0-36** Reactions between alkyl halides and thioethers

Sulfonyl Azides

- 0-116** Reaction between sulfonyl halides and azide ion

Sulfonyl Halides

- 0-117** From sulfonic acids and derivatives
1-8 Halosulfonation of aromatic rings
2-29 Reaction of Grignard reagents with sulfonyl chloride or with SO_2 followed by X_2
4-12 Free-radical halosulfonation (Reed)
4-27 Reaction of diazonium salts with SO_2 and CuCl_2

Sulfoxides

- 0-94** Alkylation of sulfoxides
0-109 Reaction between carboxylic esters and methylsulfinyl anion
1-9 Sulfurization of aromatic rings with thionyl chloride
2-29 Reaction of Grignard reagents with sulfinic esters
5-18 Addition of organometallic compounds to unsaturated sulfoxides
5-38 Treatment of alkenes with O_2 and RSH

- 6-41** Addition of sulfoxides to aldehydes or ketones (Knoevenagel)

- 9-31** Oxidation of thioethers

- 9-56** Indirectly, from sulfones

Thioamides

- 1-21** Amidation of aromatic rings with isothiocyanates
4-14 From thioaldehydes generated in situ
6-36 Addition of Grignard reagents to isothiocyanates
9-72 Reaction of ketones with sulfur and ammonia or amines

Thiocarbamates

- 6-5** Hydrolysis of thiocyanates
6-8 Addition of alcohols to isothiocyanates

Thiocyanates

- 0-42** Reaction between alkyl halides and thiocyanate ion
3-5 Reaction between aryl halides and thiocyanate ion
3-21 Reaction between diazonium salts and thiocyanate ion
4-39 Reaction between acyl peroxides and copper thiocyanate
5-28 Addition of halogen and SCN to alkenes

Thioethers

- 0-36** Reaction between alkyl halides and thiolate ions or Na_2S
0-97 Alkylation of thioethers
1-9 Sulfurization of aromatic rings
1-26 Thioalkylation of aromatic rings
2-13 Sulfonylation of ketones, carboxylic esters, and amides
2-29 Reaction between Grignard reagents and sulfur or disulfides
3-5 Reaction between aryl halides and thiolate ions
3-21 Reaction between diazonium salts and thiolate ions or Na_2S
4-36 Reduction of dithioacetals
5-6 Addition of thiols to olefins
5-28 Addition of sulfonyl chlorides to olefins

Thioethers (continued)

- 5-43 Diarylamino-arylthio-addition to double bonds
- 6-11 Reductive alkylation of thiols
- 7-11 Cleavage of sulfonium compounds
- 8-22 Rearrangement of sulfonium salts (Stevens)
- 8-37 [2,3] Sigmatropic rearrangements of sulfur ylides
- 9-40 Reduction of thiol esters
- 9-56 Reduction of sulfoxides or sulfones
- 9-60 Reduction of disulfides

Thiol Acids and Esters

- 0-36 Reaction between alcohols and thiol acids
- 0-37 Reaction between acid derivatives and thiols or H₂S
- 1-27 Reaction between aromatic rings and thiocyanates
- 5-3 Hydration of acetylenic thioethers
- 5-6 Addition of thiol acids to olefins; addition of thiols to ketenes
- 5-23 Hydrocarboxylation of olefins in the presence of thiols
- 6-11 From carboxylic acids, alcohols, and P₄S₁₀
- 6-38 Addition of Grignard reagents to carbon disulfide
- 7-50 From thiol acids and α -halo ketones

Thiols

- 0-10 Hydrolysis of thiol esters
- 0-35 Reaction of alkyl halides with NaSH; cleavage of isothiuronium salts
- 1-9 Sulfurization of aromatic compounds (Herz)
- 2-29 Reaction between Grignard reagents and sulfur
- 3-5 Reaction between aryl halides and NaSH
- 3-21 Reaction between diazonium salts and NaSH
- 5-6 Addition of H₂S to olefins
- 6-38 Addition of lithium dialkylcopper reagents to dithiocarboxylic esters
- 9-54 Reduction of sulfonic acids or sulfonyl halides
- 9-61 Reduction of disulfides

Thioketones

- 6-11 From ketones

Thiono Esters and Thioamides

- 6-11 From carboxylic esters or amides
- 6-64 Addition of imines to thioketenes (β -thiolactams)

Thioureas (see Ureas)**Triazenes**

- 1-4 Reaction between aromatic amines and diazonium salts
- 2-51 Reaction between amines and diazonium salts

Unsaturated Acids, Esters, Aldehydes, Ketones (see Unsaturated Carbonyl Compounds)**Unsaturated Alcohols and Phenols**

- 2-2 Isomerization of allylic alcohols (formation of enols)
- 4-4 Allylic hydroxylation
- 5-10 Selective reduction of α,β -unsaturated aldehydes or ketones
- 5-18 Addition of organometallic compounds to propargylic alcohols
- 6-25 Selective reduction of α,β -unsaturated aldehydes or ketones
- 6-29 Addition of vinylic or alkynyl organometallic compounds to aldehydes or ketones
- 6-41 Condensation of alkyne salts with aldehydes or ketones
- 6-47 Reaction of certain ylides with aldehydes (scoopy reactions)
- 6-53 Addition of aldehydes to olefins (Prins)
- 7-2 Reaction of epoxides with strong bases
- 7-12 From epoxides or alkenes via selenoxide cleavage
- 8-3 Ring opening of cycloalkyl carbocations
- 8-33 Rearrangement of Li salts of 2-vinylcyclopropanols
- 8-35 Rearrangement of allylic aryl ethers (Claisen)
- 8-37 [2,3] Sigmatropic rearrangements

Unsaturated Carbonyl Compounds

- 0-95** Vinylation of ketones or carboxylic esters
- 0-97** Hydrolysis of bis(methylthio)-alkenes
- 2-2** Isomerization of α -hydroxy alkynes and alkynes
- 2-15** Acylation of olefins
- 2-27** From lithium acetylides
- 2-32** From vinylic organometallic compounds
- 2-55** From allylic amines and CO
- 4-6** Oxidation of unsaturated aldehydes
- 4-40** Decarboxylative allylation of keto acids
- 5-17** Addition to activated alkynes (Michael)
- 5-18** Addition of vinylic organometallic compounds to unsaturated carbonyl compounds; addition of organometallic compounds to acetylenic carbonyl compounds
- 5-19** Addition of unsaturated boranes to methyl vinyl ketones
- 5-23** Hydrocarboxylation of triple bonds
- 5-34** Addition of acyl halides to triple bonds
- 5-35** 1,4-Addition of acetals to dienes
- 6-16** Reaction between aldehydes, ammonia, and aldehydes, ketones, or carboxylic esters (Mannich)
- 6-30** Reaction between aldehydes or ketones, zinc, and α -halo esters (Reformatsky)
- 6-39** Condensation of aldehydes and/or ketones (aldol)
- 6-40** Condensation between carboxylic esters and aldehydes or ketones
- 6-41** Condensation between active-hydrogen compounds and aldehydes or ketones (Knoevenagel)
- 6-44** Condensation between anhydrides and aldehydes (Perkin)
- 6-47** Condensation between β -carboxy phosphoranes and aldehydes or ketones
- 7-3** Pyrolysis of lactones
- 7-12** Cleavage of carbonyl-containing selenoxides and sulfones
- 7-35** Fragmentation of epoxy hydrazones

- 8-31** Rearrangement of vinylic hydroxycyclopropanes
- 8-34** Rearrangement of 3-hydroxy-1,5-dienes (oxy-Cope)
- 8-35** Rearrangement of allylic vinylic ethers (Claisen)
- 8-37** [2,3] Sigmatropic rearrangements
- 9-2** Dehydrogenation of aldehydes or ketones
- 9-16** Oxidation of a methylene group α to a double or triple bond

Unsaturated Ethers and Thioethers

- 0-97** Alkylation of allylic ethers
- 7-31** Elimination of X and OR from β -halo acetals
- 8-37** [2,3] Sigmatropic rearrangement of allylic sulfur ylides

Unsaturated Nitriles, Nitro Compounds, and Sulfonic Acids and Esters

- 2-33** Cyanation of vinylic organometallic compounds
- 5-17** Addition to activated alkynes (Michael)
- 5-18** Addition of organometallic compounds to activated alkynes
- 5-25** Addition of HCN to alkynes
- 5-33** Addition of nitril chloride to triple bonds
- 6-41** Condensation between active hydrogen compounds and aldehydes or ketones (Knoevenagel)
- 7-18** Cleavage of H and HgCl from β -nitro mercuric halides
- 8-35** Rearrangement of allylic vinylic sulfones and sulfoxides

Ureas and Thioureas

- 0-56** Exchange of ureas
- 2-55** Carbonylation of amines
- 6-17** Addition of amines to isocyanates or isothiocyanates
- 6-19** Addition of amines to CO₂ or CS₂
- 6-55** Addition of alcohols or other carbocation sources to cyanamides (Ritter)
- 8-14** Reaction between amides and lead tetraacetate

Ureides (see Imides)

Urethanes (*see* Carbamates)

Vinylic Ethers (*see* Enol Ethers)

Vinylic Halides

0-65 Halide exchange

2-30 Halogenation of alkenyl organometallic compounds

5-1 Addition of hydrogen halides to triple bonds

5-26 Halogenation of alkynes or allenes

5-33 Addition of alkyl halides to triple bonds

5-34 Addition of acyl halides to triple bonds

6-24 Addition of PCl_5 to aldehydes or ketones

6-47 Reaction of halophosphoranes with aldehydes or ketones; reaction of certain ylides with halogen compounds (scoopy reactions)

Xanthates

6-10 Addition of alcohols to carbon disulfide

7-4 Reaction of alcohols with NaOH and CS_2 , followed by methyl iodide

Ylides (*see* Nitrogen Ylides, Phosphoranes)