Many chapters contain brief discussions of reactions and comparisons of alternative synthetic methods related to the reaction that is the subject of the chapter. These related reactions and alternative methods are not usually listed in this index. In this index, the volume number is in **boldface**, the chapter number is in ordinary type.

Acetoacetic ester condensation, 1, 9 Acetylenes: cotrimerizations of, 68, 1 oxidation by dioxirane, 69, 1 reactions with Fischer carbene complexes, phenol and quinone formation, 70, 2 synthesis of, 5, 1; 23, 3; 32, 2 Acid halides: reactions with esters, 1, 9 reactions with organometallic compounds, 8, 2 α -Acylamino acid mixed anhydrides, **12**, 4 α -Acylamino acids, azlactonization of, 3, 5 Acylation: intramolecular, to form cyclic ketones, 2, 4; 23, 2 of esters with acid chlorides, 1, 9 of ketones to form diketones, 8, 3 Acyl fluorides, synthesis of, 21, 1; 34, 2; **35**, 3 Acyl hypohalites, reactions of, 9, 5 Acyloins, 4, 4; 15, 1; 23, 2 Alcohols: conversion to fluorides, **21**, 1, 2; **34**, 2; **35**, 3 conversion to olefins, 12, 2 deoxygenation of, 77, 2 oxidation of, 6, 5; 39, 3; 53, 1; 74, 2 replacement of hydroxy group by nucleophiles, 29, 1; 42, 2

resolution of, 2, 9 Alcohols, synthesis: by allylstannane addition to aldehydes, 64, 1 by base-promoted isomerization of epoxides, 29, 3 by hydroboration, 13, 1 by hydroxylation of ethylenic compounds, 7, 7 by organochromium reagents to carbonyl compounds, 64, 3 by reduction, 6, 10; 8, 1; 71, 1 from organoboranes, 33, 1; 73, 1 Aldehydes, additions of allyl, allenyl, propargyl stannanes, 64, 1 addition of allylic boron compounds, 73, 1 Aldehydes, catalyzed addition to double bonds, 40, 4 Aldehydes, dimerization by alkoxides, 86, 2 Aldehydes, synthesis of, 4, 7; 5, 10; 8, 4, 5; 9.2:33.1 Aldol condensation, 16; 67, 1 catalytic, enantioselective, 67, 1 directed, 28, 3 with boron enolates, 51, 1 Aldol-Tishchenko reaction, 86, 2 Aliphatic fluorides, 2, 2; 21, 1, 2; 34, 2; 35, 3 Alkanes: by reduction of alkyl halides with organochromium reagents, 64, 3

Organic Reactions, Vol. 86, Edited by Scott E. Denmark et al.

© 2015 Organic Reactions, Inc. Published 2015 by John Wiley & Sons, Inc.

Alkanes: by reduction (Continued) of carbonyl groups with organosilanes, 71.1 oxidation of, 69, 1 via alcohol deoxygenation, 77, 2 Alkenes: arylation of, 11, 3; 24, 3; 27, 2 asymmetric dihydroxylation, 66, 2 cyclopropanes from, 20, 1 cyclization in intramolecular Heck reactions, 60, 2 from carbonyl compounds with organochromium reagents, 64, 3 dioxirane epoxidation of, 61, 2 epoxidation and hydroxylation of, 7, 7 epoxidation of electron-deficient, 74, 3 free-radical additions to, 13, 3, 4 hydroboration of, 13, 1 hydrocyanation of, 75, 1 hydrogenation with homogeneous catalysts, 24, 1 oxidation with palladium catalyst, 84, 2 reactions with diazoacetic esters, 18, 3 reactions with nitrones, 36, 1 reduction by: alkoxyaluminum hydrides, 34, 1 diimides, 40, 2 organosilanes, 71, 1 Alkenes, synthesis: by Bamford-Stevens reaction, 23, 3 by Claisen and Cope rearrangements, 22, 1 by dehydrocyanation of nitriles, 31 by deoxygenation of vicinal diols, **30**, 2 by deoxygenative coupling of carbonyl compounds, 82, 1 by McMurray reaction, 82, 1 by palladium-catalyzed vinylation, 27, 2 by pyrolysis of xanthates, **12**, 2 by Wittig reaction, 14, 3 from amines, 11, 5 from aryl and vinyl halides, 27, 2 from α -halosulfones, **25**, 1; **62**, 2 from phosphoryl-stabilized anions, 25, 2 from silicon-stabilized anions, 38, 1 from tosylhydrazones, 23, 3; 39, 1 from twofold extrusion reactions, 78, 3

Alkenyl- and alkynylaluminum reagents, **32**. 2 Alkenylelectrophiles, 83, 1 lithiums, formation of, 39, 1 silanes, 75, 3 trifluoroborates, 79, 1 Alkoxyaluminum hydride reductions, 34, 1; 36, 3 Alkoxyphosphonium cations, nucleophilic displacements on, 29, 1 Alkoxysilanes, 75, 3 Alkylation: of allyl alcohol esters, 84, 1 of allylic and benzylic carbanions, 27, 1 with amines and ammonium salts, 7, 3 of aromatic compounds, 3, 1 of esters and nitriles, 9, 4 γ -, of dianions of β -dicarbonyl compounds, 17, 2 of metallic acetylides, 5, 1 of nitrile-stabilized carbanions, 31 with organopalladium complexes, 27, 2 Alkyl azides, use in Schmidt Reaction, 78, 1 Alkylidenation by titanium-based reagents, 43, 1 Alkylidenesuccinic acids, synthesis and reactions of, 6, 1 Alkylidene triphenylphosphoranes, synthesis and reactions of, 14, 3 Alkynes, hydrocyanation of, 75, 1 Alkynyl: silanes, 75, 3 trifluoroborates, 79, 1 Allenylsilanes, electrophilic substitution reactions of, 37, 2 Allylboration of carbonyl compounds, 73, 1 Allylsilanes, 75, 3 Allyl transfer reactions, 73, 1 Allylic alcohols, synthesis: from epoxides, 29, 3 by Wittig rearrangement, 46, 2 Allylic amines, 83, 2 Allylic and benzylic carbanions, heteroatom-substituted, 27, 1 Allylic hydroperoxides, in photooxygenations, 20, 2

Allylic rearrangements, transformation of glycols into 2,3-unsaturated glycosyl derivatives, 62, 4 Allylic rearrangements, trihaloacetimidate, **66**, 1 π -Allylnickel complexes, **19**, 2 Allylphenols, synthesis by Claisen rearrangement, 2, 1; 22, 1 Allylsilanes, electrophilic substitution reactions of, 37, 2 Aluminum alkoxides: in Meerwein-Ponndorf-Verley reduction, 2, 5 in Oppenauer oxidation, 6, 5 Amides: arylation of, 85, 1 cyclopropanation of, 77, 1 formation by oxime rearrangement, 35, 1 from ketones, 78, 1 α -Amidoalkylations at carbon, 14, 2 Amination: electrophilic, of carbanions and enolates, 72, 1 of heterocyclic bases by alkali amides, 1, of hydroxy compounds by Bucherer reaction, 1, 5 Amine oxides: Polonovski reaction of, 39, 2 pyrolysis of, 11, 5 Amines: N-arylation of, 85, 1 from allylstannane addition to imines, **64**. 1 from carbocations, 78, 1 from carboxylic acids, 3, 9; 78, 1 oxidation of, 69, 1 synthesis from organoboranes, 33, 1 synthesis by reductive alkylation, 4, 3; 5, 7 synthesis by Zinin reaction, 20, 4 reactions with cyanogen bromide, 7, 4 α-Amino acid derivatives, from borono-Mannich reactions, 83, 2 α-Amino acid synthesis, via Strecker reaction, 70, 1 α -Aminoalkylation of activated olefins, **51**, 2 α-Amino ketones, from borono-Mannich reactions, 83, 2

from oxime derivatives, 78, 2 Aminophenols from anilines, 35, 2 Anhydrides of aliphatic dibasic acids, Friedel-Crafts reaction with, 5, 5 Anion-assisted sigmatropic rearrangements, 43, 2 Anthracene homologs, synthesis of, 1, 6 Anti-Markownikoff hydration of alkenes, 13, π -Arenechromium tricarbonyls, reaction with nitrile-stabilized carbanions, 31 η^6 -(Arene)chromium complexes, 67, 2 Arndt-Eistert reaction, 1, 2 Aromatic aldehydes, synthesis of, 5, 6; 28, 1 Aromatic compounds, chloromethylation of, 1,3 Aromatic fluorides, synthesis of, 5, 4 Aromatic hydrocarbons, synthesis of, 1, 6; 30.1 Aromatic substitution by the S_{RN} 1 reaction, 54, 1 Arsinic acids, 2, 10 Arsonic acids, 2, 10 Arylacetic acids, synthesis of, 1, 2; 22, 4 β -Arylacrylic acids, synthesis of, 1, 8 Aryl amines, reactions of, 1, 5; 85, 1 Arylation: by aryl halides, 27, 2 by copper catalysis, 85, 1 by diazonium salts, 11, 3; 24, 3 γ -, of dianions of β -dicarbonyl compounds, 17, 2 of alkenes, 11, 3; 24, 3; 27, 2 of enolates, 76, 2 of ketones, 76, 2 of nitrile-stabilized carbanions, 31, 1 Aryl diazo acetates, 75, 2 Arylglyoxals, condensation with aromatic hydrocarbons, 4, 5 Arylsilanes, 75, 3 Arylsulfonic acids, synthesis of, 3, 4 Aryltrifluoroborates, 79, 1 Aryl halides, homocoupling of, 63, 3 cross-coupling, 83, 1 Aryl thiocyanates, 3, 6 Asymmetric aldol reactions using boron enolates, 51, 1 Asymmetric cyclopropanation, 57, 1

Boronic acid Mannich reaction, 83, 2

lithium amides, 79, 2 Asymmetric dihydroxylation, 66, 2 Asymmetric epoxidation, 48, 1; 61, 2; 74, 3 Asymmetric hydrocyanation, 75, 1 Asymmetric hydrogenation of C=N, 74, 1 Asymmetric reduction, 71, 1 Asymmetric Strecker reaction, 70, 1 Atom transfer preparation of radicals, 48, 2 Aza-Cope/Mannich reaction, 75, 4 Aza-Payne rearrangements, 60, 1 Azaphenanthrenes, synthesis by photocyclization, 30, 1 Azides, synthesis and rearrangement of, 3,9 2H-Azirines, from Neber rearrangement of oxime derivatives, 78, 2 Azlactones, 3, 5 Baeyer-Villiger reaction, 9, 3; 43, 3 Bamford-Stevens reaction, 23, 3 Barbier Reaction, 58, 2 Bart reaction, 2, 10 Barton fragmentation reaction, 48, 2 Barton-McCombie reaction, 77, 2 Béchamp reaction, 2, 10 Beckmann rearrangement, 11, 1; 35, 1 Benzils, reduction of, 4, 5 Benzoin condensation, 4, 5 Benzoquinones: acetoxylation of, 19, 3 in Nenitzescu reaction, 20, 3 synthesis of, 4, 6 Benzylic carbanions, 27, 1; 67, 2 Benzylic deprotonations, 79, 2 Benzyl: silanes, 75, 3 trifluoroborates, 79, 1 Biaryls, synthesis of, 2, 6; 63, 3; 79, 1 Bicyclobutanes, from cyclopropenes, 18, 3 Biginelli dihydropyrimidine synthesis, 63.1 Birch reaction, 23, 1; 42, 1 Bischler-Napieralski reaction, 6, 2 Bis(chloromethyl) ether, 1, 3; 19, warning Boron enolates, 51, 1 Borane reagents, for allylic transfer, 73, 1 Borohydride reduction, chiral, 52, 2

Asymmetric deprotonation with chiral

in reductive amination, **59**, 1

Boyland-Sims oxidation, 35, 2 Bucherer reaction, 1, 5; 85, 1 Cannizzaro reaction, 2, 3 Carbanion, electrophilic amination, 72, 1 Carbenes, 13, 2; 26, 2; 28, 1 Carbene complexes in phenol and quinone synthesis, 70, 2 Carbenoids, in cyclopropanation, 57, 1; 58, 1; 77, 1 intermolecular C-H insertions of, 75, 2 Carbohydrates, deoxy, synthesis of, 30, 2 Carbometallocupration, 41, 2 Carbon-carbon bond formation: by acetoacetic ester condensation, 1, 9by acyloin condensation, 23, 2 by aldol condensation, 16, 1; 28, 3; 46, 1; **67**. 1 by alkylation of allyl alcohol esters, 84, 1 by alkylation with amines and ammonium salts, 7, 3 by γ -alkylation and arylation, **17**, 2 by allylic and benzylic carbanions, 27, 1 by amidoalkylation, 14, 2 by Cannizzaro reaction, 2, 3 by C-H insertion reaction, 80, 1 by Claisen rearrangement, 2, 1; 22, 1 by Cope rearrangement, 22, 1 by cross-coupling with organotrifluoroborate salts, 79, 1 by cyclopropanation reaction, 13, 2; 20, 1 by Darzens condensation, 5, 10 by diazonium salt coupling, 10, 1; 11, 3; 24, 3 by Dieckmann condensation, 15, 1 by Diels-Alder reaction, 4, 1, 2; 5, 3; 32, by free-radical additions to alkenes, 13, 3 by Friedel-Crafts reaction, 3, 1; 5, 5 by Knoevenagel condensation, 15, 2 by Mannich reaction, 1, 10; 7, 3 by Michael addition, 10, 3 by nitrile-stabilized carbanions, 31 by organoboranes and organoborates, 33, by organocopper reagents, 19, 1; 38, 2; 41, 2 by organopalladium complexes, 27, 2

by organozinc reagents, 20, 1 by rearrangement of α -halosulfones, 25, 1:62.2 by Reformatsky reaction, 1, 1; 28, 3 by trivalent manganese, 49, 3 by Vilsmeier reaction, 49, 1; 56, 2 by vinylcyclopropane-cyclopentene rearrangement, 33, 2 Carbon-fluorine bond formation, 21, 1; 34, 2; 35, 3; 69, 2 Carbon-halogen bond formation, by replacement of hydroxyl groups, 29.1 Carbon-heteroatom bond formation: by free-radical chain additions to carbon-carbon multiple bonds, 13, 4 by organoboranes and organoborates, 33, 1 Carbon-nitrogen bond formation, by copper-catalyzed arylation and vinylation, 85, 1 by reductive amination, 59, 1 Carbon-phosphorus bond formation, 36, 2 Carbonyl compounds, addition of organochromium reagents, 64, 3 Carbonyl compounds, α , β -unsaturated: formation by selenoxide elimination, 44, 1 vicinal difunctionalization of, 38, 2 Carbonyl compounds, from nitro compounds, 38, 3 in the Passerini Reaction, 65, 1 oxidation with hypervalent iodine reagents, 54, 2 reactions with allylic boron compounds, 73, 1 reductive amination of, 59, 1 Carbonyl ylides from diazocarbonyl compounds, 80, 2 Carbonylation as part of intramolecular Heck reaction, 60, 2 Carboxylic acid derivatives, conversion to fluorides, 21, 1, 2; 34, 2; 35, 3 cyclopropanation of, 77, 1 Carboxylic acids: synthesis from organoboranes, 33, 1 reaction with organolithium reagents, 18, 1

Catalytic asymmetric allylic alkylation, 84, 1 Catalytic asymmetric hydrogenation of C=N functions, 74, 1 Catalytic enantioselective aldol addition, **67**, 1 Catalytic enantioselective ketene cycloadditions, 82, 2 C-H functionalization, 75, 2; 80, 1 C-H insertions, intramolecular with carbenoids, 80, 1 intermolecular with carbenoids, 75, 2 Chapman rearrangement, 14, 1; 18, 2 Chiral lithium amides, 79, 2 Chloromethylation of aromatic compounds, 2, 3; 9, warning Cholanthrenes, synthesis of, 1, 6 Chromium reagents, 64, 3; 67, 2 Chugaev reaction, 12, 2; 77, 2 Claisen condensation, 1, 8 Claisen rearrangement, 2, 1; 22, 1 Cleavage: of benzyl-oxygen, benzyl-nitrogen, and benzyl-sulfur bonds, 7, 5 of carbon-carbon bonds by periodic acid, 2,8 of esters via S_N2-type dealkylation, 24.2 of non-enolizable ketones with sodium amide, 9, 1 in sensitized photooxidation, 20, 2 Clemmensen reduction, 1, 7; 22, 3 Collins reagent, 53, 1 Condensation: acetoacetic ester, 1, 9 acyloin, 4, 4; 23, 2 aldol, 16 benzoin, 4, 5 Biginelli, 63, 1 Claisen, 1, 8 Darzens, 5, 10; 31 Dieckmann, 1, 9; 6, 9; 15, 1 directed aldol, 28, 3 Knoevenagel, 1, 8; 15, 2 Stobbe, 6, 1 Thorpe-Ziegler, 15, 1; 31 Conjugate addition: of hydrogen cyanide, 25, 3; 75, 1 of organocopper reagents, 19, 1; 41, 2 Cope rearrangement, 22, 1; 41, 1; 43, 2

Copper-catalyzed arylation: of active methylenes, 76, 2 of nitrogen nucleophiles, 85, 1 Copper-catalyzed preparation of indoles by cyclization, 76, 3 Copper-Grignard complexes, conjugate additions of, 19, 1; 41, 2 Corey-Winter reaction, 30, 2 Coumarins, synthesis of, 7, 1; 20, 3 Cross-coupling reactions with: copper catalysis, 85, 1 iron catalysts, 83, 1 organosilicon compounds, 75, 3 organostannanes, 50, 1 organotrifluoroborate salts, 79, 1 Cuprate reagents, 19, 1; 38, 2; 41, 2 Curtius rearrangement, 3, 7, 9 Cyanation, of N-heteroaromatic compounds, 70, 1 Cyanoborohydride, in reductive aminations, 59, 1 Cyanoethylation, 5, 2 Cyanogen bromide, reactions with tertiary amines, 7, 4 Cyclic ketones, formation by intramolecular acylation, 2, 4; 23, 2 Cyclization: of alkyl dihalides, 19, 2 of aryl-substituted aliphatic acids, acid chlorides, and anhydrides, 2, 4; 23, 2 of α -carbonyl carbenes and carbenoids, 26, 2 cycloheptenones from α -bromo ketones, 29.2 of diesters and dinitriles, 15, 1 Fischer indole, 10, 2 intramolecular by acylation, 2, 4 intramolecular by acyloin condensation, 4,4 intramolecular by Diels-Alder reaction, 32, 1 intramolecular by Heck reaction, 60, 2 intramolecular by Michael reaction, 47, 2 Nazarov, 45, 1 by radical reactions, 48, 2 of stilbenes, 30, 1 tandem cyclization by Heck reaction, **60**, 2 Cycloaddition reactions,

[2 + 2], 82, 2[3 + 2], **61**, 1; **80**, 2 [4+2], 4, 1, 4, 2, 32, 1, 65, 2, 82, 2 [4+3], 51, 3[6+4], 49, 2of cyclenones and quinones, 5, 3 of diazocarbonyl ylides, 80, 2 cyclobutanes, synthesis of, 12, 1; 44, 2 cyclotrimerization of acetylenes, 68, 1 Diels-Alder, acetylenes and alkenes, 4, 2 Diels-Alder, imino dienophiles, 65, 2 Diels-Alder, intramolecular, 32, 1 Diels-Alder, maleic anhydride, 4, 1 of enones, 44, 2 of ketenes, 45, 2; 82, 2 of nitrones and alkenes, 36, 1 Pauson-Khand, 40, 1 photochemical, 44, 2 retro-Diels-Alder reaction, 52, 1; **53**, 2 Cyclobutanes, synthesis: from nitrile-stabilized carbanions, 31 by thermal cycloaddition reactions, 12, 1 Cycloheptadienes, from divinylcyclopropanes, 41, 1 polyhalo ketones, 29, 2 π -Cyclopentadienyl transition metal carbonyls, 17, 1 Cyclopentenones: annulation, 45, 1 synthesis, 40, 1; 45, 1 Cyclopropanation, 57, 1; 77, 1 Cyclopropane carboxylates, from diazoacetic esters, 18, 3 Cyclopropanes: from α -diazocarbonyl compounds, **26**, 2; 57, 1 from carboxylic acid derivatives, 77, 1 from metal-catalyzed decomposition of diazo compounds, 57, 1 from nitrile-stabilized carbanions, 31, 1 from tosylhydrazones, 23, 3 from unsaturated compounds, methylene iodide, and zinc-copper couple, 20, 1; 58, 1; 58, 2 Cyclopropanols, synthesis of, 77, 1 Cyclopropenes, synthesis of, 18, 3 Cyclopropylamines, 77, 1

Darzens glycidic ester condensation, 5, 10; 31, 1 DAST, 34, 2; 35, 3 Dealkoxycarbonylation of activated esters, **81**, 1 Deamination of aromatic primary amines, 2, 7 Debenzylation, 7, 5; 18, 4 Decarboxylation: of acids, 9, 5; 19, 4 of esters, 81, 1 Dehalogenation of α -haloacyl halides, 3, 3 Dehydrogenation: in synthesis of ketenes, 3, 3 in synthesis of acetylenes, 5, 1 Demjanov reaction, 11, 2 Deoxygenation: of alcohols, 77, 2 of vicinal diols, 30, 2; 77, 2 Deprotonations by chiral lithium amides, 79.2 Desoxybenzoins, conversion to benzoins, 4.5 Dess-Martin Oxidation, 53, 1 Desulfonylation reactions, 72, 2 Desulfurization: of α -(alkylthio)nitriles, 31 in alkene synthesis, 30, 2 with Raney nickel, 12, 5 Diazo compounds, carbenoids derived from, 57, 1; 75, 2 Diazoacetic esters, reactions with alkenes, alkynes, heterocyclic and aromatic compounds, 18, 3; 26, 2 α-Diazocarbonyl compounds: conversion to carbonyl ylides, 80, 2 in cyclopropanation reactions, 57, 1 insertion and addition reactions, 26, 2; 80, 1 preparation, 57, 1; 80, 1 Diazomethane: in Arndt-Eistert reaction, 1, 2 reactions with aldehydes and ketones, 8,8 Diazonium fluoroborates, synthesis and decomposition, 5, 4 Diazonium salts: coupling with aliphatic compounds, 10,

1, 2

in deamination of aromatic primary amines, 2, 7 in Meerwein arylation reaction, 11, 3; 24.3 in ring closure reactions, 9, 7 in synthesis of biaryls and aryl quinones, 2.6 Dieckmann condensation, 1, 9; 15, 1 for synthesis of tetrahydrothiophenes, 6,9 Diels-Alder reaction: intramolecular. 32. 1 retro-Diels-Alder reaction, 52, 1; **53**, 2 with alkynyl and alkenyl dienophiles, 4.2 with cyclenones and quinones, 5, 3 with imines, 65, 2 with maleic anhydride, 4, 1 Dihydrodiols, 63, 2 Dihydropyrimidine synthesis, 63, 1 Dihydroxylation of alkenes asymmetric, 66, 2 hydrogen-bond-mediated, 76, 1 Diimide, **40**, 2 Diketones: pyrolysis of diaryl, 1, 6 reduction by acid in organic solvents, 22, 3 synthesis by acylation of ketones, 8, 3 synthesis by alkylation of β-diketone anions, 17, 2 Dimethyl sulfide, in oxidation reactions, **39**. 3 Dimethyl sulfoxide, in oxidation reactions, **39**, 3 Diols: deoxygenation of, 30, 2 oxidation of, 2, 8 1,3-Diol monoesters from β -hydroxy ketones, 86, 2 Dioxetanes, 20, 2 Dioxiranes, 61, 2; 69, 1 Dioxygenases, 63, 2 Dirhodium catalysts, 75, 2 Divinyl-aziridines, -cyclopropanes, -oxiranes, and -thiiranes, rearrangements of, 41, 1

Doebner reaction, 1, 8

Eastwood reaction, 30, 2 Elbs reaction, 1, 6; 35, 2 Electrophilic: amination, 72, 1 fluorination, 69, 2 Enamines, reaction with quinones, 20, 3 Enantioselective: aldol reactions, 67, 1 allylation and crotylation, 73, 1 boronic acid Mannich reactions, 83, 2 deprotonation, 79, 2 Ene reaction, in photosensitized oxygenation, 20, 2 **Enolates:** α -Arylation, **76**, 2 Fluorination of, 69, 2 α -Hydroxylation of, **62**, 1 in directed aldol reactions, 28, 3; 46, 1; 51, 1 Enone cycloadditions, 44, 2 Enzymatic reduction, 52, 2 Enzymatic resolution, 37, 1 Epoxidation: of alkenes, 61, 2; 74, 3 of allylic alcohols, 48, 1 with organic peracids, 7, 7 Epoxide isomerizations, 29, 3 Epoxide carbonylation, 86, 1 formation, 48, 1; 61, 2; 74, 3 migration, 60, 1 ring expansion, 86, 1 Esters: acylation with acid chlorides, 1, 9 alkylation of, 9, 4 alkylidenation of, 43, 1 cleavage via S_N2-type dealkylation, 24, 2 cyclopropanation of, 77, 1 dealkoxycarbonylation of, 81, 1 dimerization, 23, 2 glycidic, synthesis of, 5, 10 hydrolysis, catalyzed by pig liver esterase, 37, 1 β -hydroxy, synthesis of, 1, 1; 22, 4 β -keto, synthesis of, **15**, 1 reaction with organolithium reagents, 18, 1 reduction of, 8, 1; 71, 1

synthesis by Mitsunobu reaction, 42, 2 Ethers, synthesis by Mitsunobu reaction, 42, 2 Evans-Tishchenko reaction, 86, 2 Exhaustive methylation, Hofmann, 11, 5 Extrusion reactions, 78, 3 Favorskii rearrangement, 11, 4 Ferrocenes, 17, 1 Fischer carbene complexes, 70, 2 Fischer indole cyclization, 10, 2 Fluorinating agents, electrophilic, 69, 2 Fluorination of aliphatic compounds, 2, 2; **21**, 1, 2; **34**, 2; **35**, 3; **69**, 2 of carbonyl compounds, 69, 2 of heterocycles, 69, 2 Fluorination: by DAST, 35, 3 by N-F reagents, 69, 2 by sulfur tetrafluoride, 21, 1; 34, 2 Formylation: by hydroformylation, 56, 1 of alkylphenols, 28, 1 of aromatic hydrocarbons, 5, 6 of aromatic compounds, 49, 1 of non-aromatic compounds, 56, 2 Free radical additions: to alkenes and alkynes to form carbon-heteroatom bonds, 13, 4 to alkenes to form carbon-carbon bonds, 13, 3 deoxygenations, 77, 2 Freidel-Crafts catalysts, in nucleoside synthesis, 55, 1 Friedel-Crafts reaction, 2, 4; 3, 1; 5, 5; 18, 1 Friedländer synthesis of quinolines, 28, 2 Fries reaction, 1, 11 Gattermann aldehyde synthesis, 9, 2

synthesis from diazoacetic esters, 18, 3

Gattermann-Koch reaction, **5**, 6 Germanes, addition to alkenes and alkynes, **13**, 4 Glycals, fluorination of, **69**, 2

transformation into glycosyl derivatives, **62**, 4 Glycosides, synthesis of, 64, 2 Glycosylating agents, 68, 2 Glycosylation on polymer supports, 68, 2 Glycosylation, with sulfoxides and sulfinates, 64, 2 Glycidic esters, synthesis and reactions of, 5, 10 Goldberg arylation, 85, 1 Gomberg-Bachmann reaction, 2, 6; 9, 7 Grundmann synthesis of aldehydes, 8, 5 Halides, displacement reactions of, 22, 2; 27, 2 Halide-metal exchange, 58, 2 Halides, synthesis: from alcohols, 34, 2 by chloromethylation, 1, 3from organoboranes, 33, 1 from primary and secondary alcohols, 29, 1 Haller-Bauer reaction, 9, 1 Halocarbenes, synthesis and reactions of, 13, 2 Halocyclopropanes, reactions of, 13, 2 Halogen-metal interconversion reactions, 6,7 α -Halo ketones, rearrangement of, 11, 4 Halosilanes, 75, 3 α -Halo sulfones, synthesis and reactions of, 25, 1; 62, 2 Heck reaction, 27, 2 intramolecular, 60, 2 Helicenes, synthesis by photocyclization, 30, 1 Heteroaryl amines, 85, 1 Heteroarylsilanes, 75, 3 Heteroatom-substituted cyclopropanes, 77, 1 Heterocyclic aromatic systems, lithiation of, **26**, 1 Heterocyclic bases, amination of, 1, 4; 85, 1 in nucleosides, 55, 1 Heterodienophiles, 53, 2 Hilbert-Johnson method, 55, 1 Hoesch reaction, 5, 9 Hofmann elimination reaction, 11, 5; 18, 4 Hofmann reaction of amides, 3, 7, 9

Homocouplings mediated by Cu, Ni, and Pd, **63**, 3 Homogeneous hydrogenation catalysts, 24, 1 Hunsdiecker reaction, 9, 5; 19, 4 Hydration of alkenes, dienes, and alkynes, 13, 1 Hydrazoic acid, reactions and generation of, 3.8 Hydroboration, 13, 1 Hydrocyanation: of alkenes and alkynes, 75, 1 of conjugated carbonyl compounds, 25, 3 Hydroformylation, 56, 1 Hydrogen cyanide, 25, 3; 75, 1 Hydrogenation catalysts, homogeneous, 24, 1 Hydrogenation of C=N functions, 74, 1 Hydrogenation of esters, with copper chromite and Raney nickel, 8, 1 Hydrohalogenation, 13, 4 Hydrosilylation, 75, 3 Hydroxyaldehydes, aromatic, 28, 1 α-Hydroxyalkylation of activated olefins, 51, 2 Hydroxycyclopropanes, 77, 1 α-Hydroxy ketones: rearrangement, 62, 3 synthesis of, 23, 2 Hydroxylation: of enolates, 62, 1 of ethylenic compounds with organic peracids, 7, 7 Hypervalent iodine reagents, 54, 2; 57, 2

Imidates, rearrangement of, **14**, 1 Imines, additions of allyl, allenyl, propargyl stannanes, **64**, 1 additions of cyanide, **70**, 1 as dienophiles, **65**, 2 catalytic asymmetric hydrogenation, **74**, 1 formation by twofold extrusion reactions, **78**, 3 synthesis, **70**, 1 Iminium ions, **39**, 2; **65**, 2; **75**, 4 Imino Diels-Alder reactions, **65**, 2 Indole synthesis: by catalyzed cyclization with alkenes, **76**, 3

Indole synthesis (Continued) by catalyzed cyclization with alkynes, 76, 3 by Nenitzescu reaction, 20, 3 by reaction with TosMIC, 57, 3 Intramolecular C-H insertion, 80, 1 Ionic hydrogenation, 71, 1 Iron-catalyzed cross-coupling reactions, 83.1 Iron(III) acetylacetonate (Fe(acac)₃), 83, 1 Isocyanides, in the Passerini reaction, 65, 1 sulfonylmethyl, reactions of, 57, 3 Isoquinolines, synthesis of, 6, 2, 3, 4; 20, 3 Jacobsen reaction, 1, 12 Japp-Klingemann reaction, 10, 2 Katsuki-Sharpless epoxidation, 48, 1 Ketene cycloadditions, 45, 2; 82, 2 Ketenes and ketene dimers, synthesis of, 3, 3: 45. 2 asymmetric cycloadditions, 82, 2 cycloadditions, 45, 2 α-Ketol rearrangement, 62, 3 Ketones: acylation of, 8, 3 alkylidenation of, 43, 1 Baeyer-Villiger oxidation of, 9, 3; 43, 3 cleavage of non-enolizable, 9, 1 comparison of synthetic methods, 18, 1 conversion to amides, 3, 8; 11, 1; 78, 1 conversion to fluorides, 34, 2; 35, 3 cyclic, synthesis of, 2, 4; 23, 2 cyclization of divinyl ketones, 45, 1 reaction with diazomethane, 8, 8 reduction to aliphatic compounds, 4, 8 reduction by: alkoxyaluminum hydrides, 34, 1 organosilanes, 71, 1 reduction in anhydrous organic solvents, 22, 3 synthesis by oxidation of alcohols, 6, 5; **39**, 3 synthesis from acid chlorides and organo-metallic compounds, 8, 2; 18, 1 synthesis from organoboranes, 33, 1

synthesis from organolithium reagents and carboxylic acids, **18**, 1 synthesis from α,β -unsaturated carbonyl compounds and metals in liquid ammonia, **23**, 1 Kindler modification of Willgerodt reaction, **3**, 2 Knoevenagel condensation, **1**, 8; **15**, 2; **57**, 3 Koch-Haaf reaction, **17**, 3 Kornblum oxidation, **39**, 3 Kostaneki synthesis of chromanes, flavones, and isoflavones, **8**, 3 Krapcho dealkoxycarbonylation, **81**, 1 Kulinkovich cyclopropanation, **77**, 1

Lactams: by intramolecular C-H insertion, 80, 1 from cyclic ketones, 78, 1 β-Lactams, synthesis of, 9, 6; 26, 2, 82, 1, 2 Lactones by intramolecular C-H insertion, 80.1 β -Lactones, by ketene cycloadditon, 82, 2 by ring expansion of epoxides, 86, 1 synthesis and reactions of, 8, 7 δ -Lactones by ring expansion of epoxides, 86, 1 γ-Lactones by ring expansion of epoxides, 86, 1 Leuckart reaction, 5, 7 Lithiation: of allylic and benzylic systems, 27, 1 by halogen-metal exchange, 6, 7 heteroatom facilitated, 26, 1; 47, 1 of heterocyclic and olefinic compounds, 26, 1 with chiral lithium amides, 79, 2 Lithioorganocuprates, 19, 1; 22, 2; 41, 2 Lithium aluminum hydride reductions, 6, 2 chirally modified, 52, 2 Lithium dialkylamides, 79, 2 Lossen rearrangement, 3, 7, 9 Mannich reaction, 1, 10; 7, 3; 75, 4; 83, 2 McMurry coupling reaction, 82, 1 Meerwein arylation reaction, 11, 3;

Meerwein-Ponndorf-Verley reduction, 2, 5

24, 3

Mercury hydride method to prepare radicals, 48, 2 Metal-catalyzed hydrocyanation, 75, 1 Metalations with organolithium compounds, 8, 6; 26, 1; 27, 1 Metallocarbenes: conversion to carbonyl ylides, 80, 2 insertion in C-H bonds, 80, 1 Methylenation of carbonyl groups, 43, 1 Methylenecyclopropane, in cycloaddition reactions, 61, 1 Methylene-transfer reactions, 18, 3; 20, 1; 58, 1 Michael reaction, 10, 3; 15, 1, 2; 19, 1; 20, 3; 46, 1; 47, 2 Microbiological oxygenations, 63, 2 Mitsunobu reaction, 42, 2 Moffatt oxidation, 39, 3; 53, 1 Molybdenum-catalyzed allylic alkylation, 84, 1 Morita-Baylis-Hillman reaction, 51, 2

Nagata reaction, 25, 3 Nazarov cyclization, 45, 1 Neber rearrangement, 78, 2 Nef reaction, 38, 3 Nenitzescu reaction, 20, 3 Nitriles: cyclopropanation of, 77, 1 formation from: aldehydes, 78, 1 alkenes and alkynes, 75, 1 α -cyano esters, **81**, 1 oximes, 35, 2 synthesis from organoboranes, 33, 1 α,β -unsaturated: by elimination of selenoxides, 44, 1 Nitrile-stabilized carbanions: alkylation and arylation of, 31 Nitroamines, 20, 4 Nitro compounds, conversion to carbonyl compounds, 38, 3 Nitro compounds, synthesis of, 12, 3 Nitrone-olefin cycloadditions, 36, 1 Nitrosation, 2, 6; 7, 6 Nitroxide-catalyzed oxidations, 74, 2 Nucleosides, synthesis of, 55, 1

Olefin formation: by reductive elimination of β -hydroxysulfones, **72**, 2 by twofold extrusion reactions, 78, 3 Olefins: hydrocyanation of, 75, 1 hydroformylation of, 56 oxidation of, 84, 2 Oligomerization of 1,3-dienes, 19, 2 Oligosaccharide synthesis on polymer support, 68, 2 Oppenauer oxidation, 6, 5 Organoboranes: formation of carbon-carbon and carbon-heteroatom bonds from, 33.1 in allylation of carbonyl compounds, 73, 1 in boronic acid Mannich reactions, 83, 2 in cross-coupling reactions, 79, 1 isomerization and oxidation of, 13, 1 reaction with anions of α -chloro nitriles. 31, 1 Organochromium reagents: addition to carbonyl compounds, 64, 3; 67, 2 addition to imines, 67, 2 Organohypervalent iodine reagents, 54, 2; **57**, 2 Organometallic compounds: coupling reactions with electrophiles, 83, 1 of aluminum, 25, 3 of chromium, 64, 3; 67, 2 of copper, 19, 1; 22, 2; 38, 2; 41, 2 of lithium, 6, 7; 8, 6; 18, 1; 27, 1 of magnesium, zinc, and cadmium, 8, 2 of palladium, 27, 2 of silicon, 37, 2 of tin, 50, 1; 64, 1 of zinc, 1, 1; 20, 1; 22, 4; 58, 2 Organonitriles, 75, 1 Organosilanols, 75, 3 Organosilicon hydride reductions, 71, 1 Organotrifluoroborates, in cross-coupling reactions, 79, 1 Osmium tetroxide dihydroxylation asymmetric, 66, 2

hydrogen-bond directed, 76, 1

Overman rearrangement of allylic imidates, **66**, 1 1,3-Oxazine-2,4-diones from epoxides, 86, 1 1,3-Oxathiolan-2-ones from epoxides, 68, 1 Oxidation: by dioxiranes, 61, 2; 69, 1 by oxoammonium and nitroxide catalysts, 74, 2 of alcohols and polyhydroxy compounds, 6, 5; 39, 3; 53, 1 of aldehydes and ketones, Baeyer-Villiger reaction, 9, 3; 43, 3 of amines, phenols, aminophenols, diamines, hydroquinones, and halophenols, 4, 6; 35, 2 of enolates and silyl enol ethers, 62, 1 of α -glycols, α -amino alcohols, and polyhydroxy compounds by periodic acid, 2, 8 with hypervalent iodine reagents, 54, 2 of organoboranes, 13, 1 of phenolic compounds, 57, 2 with peracids, 7, 7 by photooxygenation, 20, 2 with selenium dioxide, 5, 8; 24, 4 Oxidative decarboxylation, 19, 4 Oximes: conversion to α -amino ketones, 78, 2 conversion to 2H-azirines, 78, 2 formation by nitrosation, 7, 6 Oxoammonium-catalyzed oxidation, 74, 2 Oxochromium(VI)-amine complexes, 53, 1 Oxo process, 56, 1 Oxygenation of arenes by dioxygenases, **63**, 2

Palladium-catalyzed:
arylation of enolates, 76, 2
cross-coupling of:
organostannanes, 50, 1
organotrifluoroborates, 79, 1
indole synthesis by cyclization, 76, 3
oxidation of alkenes, 84, 2
vinylic substitution, 27, 2
Palladium intermediates in Heck reactions, 60, 2
Passerini reaction, 65, 1
Pauson-Khand reaction to prepare
cyclopentenones, 40, 1

Payne rearrangement, 60, 1 Pechmann reaction, 7, 1 Peptides, synthesis of, 3, 5; 12, 4 Peracids, epoxidation and hydroxylation with, 7, 7 in Baeyer-Villiger oxidation, 9, 3; 43, 3 Periodic acid oxidation, 2, 8 Perkin reaction, 1, 8 Persulfate oxidation, 35, 2 Petasis borono-Mannich reaction, 83, 2 Peterson olefination, 38, 1 Phenanthrenes, synthesis by photocyclization, 30, 1 Phenols, dihydric from phenols, 35, 2 oxidation of, 57, 2 synthesis from Fischer carbene complexes, 70, 2 Phosphinic acids, synthesis of, 6, 6 Phosphonic acids, synthesis of, 6, 6 Phosphonium salts: halide synthesis, use in, 29, 1 synthesis and reactions of, 14, 3 Phosphorus compounds, addition to carbonyl group, 6, 6; 14, 3; 25, 2; 36, 2 addition reactions at imine carbon, 36, 2 Phosphoryl-stabilized anions, 25, 2 Photochemical cycloadditions, 44, 2 Photocyclization of stilbenes, 30, 1 Photooxygenation of olefins, 20, 2 Photoreduction, 77, 2 Photosensitizers, 20, 2 Pictet-Spengler reaction, 6, 3 Pinacols, by McMurry reaction, 82, 1 Pig liver esterase, 37, 1 Polonovski reaction, 39, 2 Polyalkylbenzenes, in Jacobsen reaction, 1, 12 Polycyclic aromatic compounds, synthesis by photocyclization of stilbenes, 30, 1 Polyhalo ketones, reductive dehalogenation of, 29, 2 Pomeranz-Fritsch reaction, 6, 4 Prévost reaction, 9, 5 Pschorr synthesis, 2, 6; 9, 7 Pummerer reaction, 40, 3 Pyrazolines, intermediates in diazoacetic ester reactions, 18, 3

Pyridinium chlorochromate, 53, 1

Pyrolysis: of amine oxides, phosphates, and acyl derivatives, **11**, 5 of ketones and diketones, **1**, 6 for synthesis of ketenes, **3**, 3 of xanthates, **12**, 2 Pyrrolidines, by aza-Cope/Mannich reaction, **75**, 4

Quaternary ammonium N-F reagents, **69**, 2 salts, rearrangements of, **18**, 4 Quinolines, synthesis of by Friedländer synthesis, **28**, 2 by Skraup synthesis, **7**, 2 Quinones: acetoxylation of, **19**, 3 diene additions to, **5**, 3 synthesis of, **4**, 6 synthesis from Fischer carbene complexes, **70**, 2 in synthesis of 5-hydroxyindoles, **20**, 3

Ramberg-Bäcklund rearrangement, 25, 1; **62**. 2 Radical formation and cyclization, 48, 2 Radical-mediated alcohol deoxygenation, 77, 2 Rearrangements: allylic trihaloacetamidate, 66, 1 anion-assisted sigmatropic, 43, 2 Beckmann, 11, 1; 35, 1 Chapman, 14, 1; 18, 2 Claisen, 2, 1; 22, 1 Cope, 22, 1; 41, 1, 43, 2 Curtius, 3, 7, 9 divinylcyclopropane, 41, 1 Favorskii, 11, 4 Lossen, 3, 7, 9 Ramberg-Bäcklund, 25, 1; 62, 2 Smiles, 18, 2 Sommelet-Hauser, 18, 4 Stevens, 18, 4 [2,3] Wittig, 46, 2 vinylcyclopropane-cyclopentene, 33, 2 Reduction: of acid chlorides to aldehydes, 4, 7; 8, 5 of aromatic compounds, 42, 1

of benzils, 4, 5 of ketones, enantioselective, 52, 2 of O-thioacyl derivatives, 77, 2 Clemmensen, 1, 7; 22, 3 desulfurization, 12, 5 with diimide, 40, 2 by dissolving metal, 42, 1 by homogeneous hydrogenation catalysts, 24, 1 by hydrogenation of esters with copper chromite and Raney nickel, 8, 1 hydrogenolysis of benzyl groups, 7, 5 by lithium aluminum hydride, 6, 10 by Meerwein-Ponndorf-Verley reaction, 2,5 chiral, 52, 2 by metal alkoxyaluminum hydrides, 34, 1; 36, 3 by organosilanes, 71, 1 of mono- and polynitroarenes, 20, 4 of olefins by diimide, 40, 2 of α,β -unsaturated carbonyl compounds, 23, 1 by samarium(II) iodide, 46, 3 by Wolff-Kishner reaction, 4, 8 Reductive alkylation, synthesis of amines, 4, 3; 5, 7 Reductive amination of carbonyl compounds, 59, 1; 71, 1 Reductive coupling of carbonyl compounds, 82, 1 Reductive cyanation, 57, 3 Reductive desulfonylation, 72, 2 Reductive desulfurization of thiol esters, 8,5 Reformatsky reaction, 1, 1; 22, 4 Regitz deformylation diazo transfer, 80, 1 Reimer-Tiemann reaction, 13, 2; 28, 1 Reissert reaction, 70, 1 Resolution of alcohols, 2, 9 Retro-Diels-Alder reaction, 52, 1; 53, 2 Rhodium-catalyzed: C-H insertion, 80, 1 carbonyl ylide formation, 80, 2 cyclopropanation, 57, 1 Ritter reaction, 17, 3 Rosenmund reaction for synthesis of arsonic acids, 2, 10 Rosenmund reduction, 4, 7

Suzuki-Miyaura cross-coupling, 79, 1

Swern oxidation, 39, 3; 53, 1

Samarium(II) iodide, 46, 3 Sandmeyer reaction, 2, 7 Schiemann reaction, 5, 4 Schmidt reaction, 3, 8, 9; 78, 1 Selenium dioxide oxidation, 5, 8; 24, 4 Seleno-Pummerer reaction, 40, 3 Selenoxide elimination, 44, 1 Shapiro reaction, 23, 3; 39, 1 Silanes: addition to olefins and acetylenes, 13, 4 electrophilic substitution reactions, 37.2 oxidation of, 69, 1 reduction with, 71, 1; 77, 2 Silanolate salts, 75, 3 Sila-Pummerer reaction, 40, 3 Siliconates, 75.3 Silicon-based cross-coupling, 75, 3 Silyl carbanions, 38, 1 Silyl enol ether, α -hydroxylation, 62, 1 Silvl compounds, cross-coupling of, 75, 3 Simmons-Smith reaction, 20, 1; 58, 1 Simonini reaction, 9, 5 Singlet oxygen, 20, 2 Skraup synthesis, 7, 2; 28, 2 Smiles rearrangement, 18, 2 Sommelet-Hauser rearrangement, 18, 4 S_{RN}1 reactions of aromatic systems, 54, 1 Solid-phase synthesis of indoles, 76, 3 Sommelet reaction, 8, 4 Staudinger-Pfenniger reaction, 78, 3 Staudinger synthesis of β -lactams, **82**, 2 Stevens rearrangement, 18, 4 Stetter reaction of aldehydes with olefins, 40.4 Strecker reaction, catalytic asymmetric, 70, 1 Stilbenes, photocyclization of, 30, 1 Stille reaction, 50, 1 Stobbe condensation, 6, 1 Substitution reactions using organocopper reagents, 22, 2; 41, 2 Succinic anhydrides from epoxides, 86, 1 Sugars, synthesis by glycosylation with sulfoxides and sulfinates, 64, 2 Sulfide reduction of nitroarenes, 20, 4 Sulfonation of aromatic hydrocarbons and aryl halides, 3, 4

Tetrahydroisoquinolines, synthesis of, 6, 3 Tetrahydrothiophenes, synthesis of, 6.9 1,2,4-Thiadiazoles as extrusion intermediates, 78, 3 Thia-Payne rearrangement, 60, 1 Thiazoles, synthesis of, 6, 8 Thiele-Winter acetoxylation of quinones, 19.3 Thioacylationof alcohols, 77, 2 Thiocarbonates, synthesis of, 17, 3; 77, 2 Thiocyanation of aromatic amines, phenols, and polynuclear hydrocarbons, 3, 6 Thiophenes, synthesis of, 6, 9 Thorpe-Ziegler condensation, 15, 1; 31 Tiemann reaction, 3, 9 Tiffeneau-Demjanov reaction, 11, 2 Tin(II) enolates, 46, 1 Tin hydride method to prepare radicals, 48, 2 Tipson-Cohen reaction, 30, 2 Tishchenko reaction, 86, 1 Titanium, low valent species in coupling, 82.1 Tosylhydrazones, 23, 3; 39, 1 Tosylmethyl isocyanide (TosMIC), 57, 3 Transmetallation reactions, 58, 2 Tributylstannane, in xanthate reduction, 77, 2 Tricarbonyl(n⁶-arene)chromium complexes, 67, 2 Trihaloacetimidate, allylic rearrangements, **66**, 1 Trifluoroborates, in cross-coupling reactions, 79.1 Trimerization, co-, acetylenic compounds, **68**. 1 Trimethylenemethane, [3 + 2] cycloaddition of, 61, 1 Trimethylsilyl cyanide, 75, 1 Ullmann reaction, 2, 6; 14, 1; 63, 3; 85, 1

Unsaturated compounds, synthesis with alkenyl- and alkynylaluminum reagents, **32**, 2

Vilsmeier reaction, 49, 1; 56, 2
Vinylcyclopropanes, rearrangement to cyclopentenes, 33, 2
Vinyl diazo acetates, 75, 2
Vinyllithiums, from sulfonylhydrazones, 39, 1
Vinylsilanes, electrophilic substitution reactions of, 37, 2
Vinyltrifluoroborates, 79, 1
Vinyl substitution, catalyzed by palladium complexes, 27, 2
von Braun cyanogen bromide reaction, 7, 4
Vorbrüggen reaction, 55, 1

Wacker oxidation, **84**, 2 Willgerodt reaction, **3**, 2 Wittig reaction, **14**, 3; **31**, 1 [2,3]-Wittig rearrangement, **46**, 2 Wolff-Kishner reaction, **4**, 8

Xanthates: in the Barton-McCombie reaction, 77, 2 synthesis and reactions of, 12, 2; 77, 2

Ylides: in Stevens rearrangement, **18**, 4 in Wittig reaction, structure and properties, **14**, 3

Zinc-copper couple, **20**, 1; **58**, 1, 2 Zinin reduction of nitroarenes, **20**, 4

