INDEX

Acceptor phase, 11, 28, 105, 115, 310 Accuracy, 153-154 Accurel hollow fiber, 26, 115, 132t, 148, 172, 195, 289 Acetaldehyde, 185, 205 Acetone: as analyte, 211, 287-288 as biomarker, 204 as disperser solvent, 11, 24, 291, 305 as extracting solvent, 177 as fiber cleaning solvent, 26, 105, 289 as volatile release agent, 31, 289 determination in water, 287-288 physical properties, 125t as SME solvent, 119t Acetonitrile: as disperser solvent, 115, 305 as extracting solvent, 177 physical properties, 126t residual solvent in drugs, 277 as SME solvent, 120t, 192 Acids: alkylphosphonic, 192, 194

carboxylic, 60, 72, 145, 217 derivatization of, 112t fatty, 192, 196 haloacetic, 183, 185 organic, 109, 192, 200, 211 Active food packaging, 217t Agitation, 47, 56, 62, 80--81, 175, 262 magnetic stirring, 22, 48, 67, 147, 149, 175 manual shaking, 147 mechanical vibration, 47, 48, 51, 143, 147, 149.175 orbital, 23, 262 sonication, 178, 289 vortexing, 82, 262, 277, 279 Air monitoring, 173, 222 Air-water distribution coefficient, 40, 137, 152 Alcoholic beverages, 213t Alcohols: as analytes, 185, 211, 212, 277-278, 282.293 as SME solvents, 118t physical properties, 123-124t

Abbreviations: t = table; f = figure

Solvent Microextraction: Theory and Practice, By John M. Kokosa, Adrzej Przyjazny, and Michael A. Jeannot Copyright © 2009 John Wiley & Sons, Inc. Aldehydes: as analytes, 59, 109, 185, 204-205, 227 as biomarkers, 204-205 derivatization of, 112t Setschenow constant, 90 Algae, 176, 182t Aliphatic hydrocarbons: as SME solvents, 40, 116t physical properties, 122t Alkaloids, 145 Alkanes, see Aliphatic hydrocarbons Amines, 69 aromatic, 105, 192 derivatization of, 109, 111, 112t Amino acids, 109 derivatization of, 112t Ammonia, 198, 208, 211, 212 as biomarker. 205 Ammonium pyrrolidine dithiocarbamate, 197t Amyl acetate: as SME solvent, 119t physical properties, 124t Analyte binding, 88, 206, 223 Analyte enrichment, 20, 115, 128, 148, 152 Anisole: as SME solvent, 119t physical properties, 124t APDC, see Ammonium pyrrolidine dithiocarbamate Aromatic hydrocarbons: as analytes, 173, 179, 212 as SME solvents, 40, 117t physical properties, 123t Arsenic, 196, 197 Arson accelerants analysis, 281-284 Atomic absorption spectrometry, 29, 34, 80, 127, 197 Automation, 54, 109, 174 Autosampler, 22, 24, 27, 32, 63, 67, 69, 74, 107, 109, 175 Basic analytes, 145, 193, 262t, 264, 288, 310 Beer, 212, 213t Benzene: as analyte, 7, 30, 59, 87, 88, 93, 173, 179, 264-266, 267-268, 277-278 as SME solvent, 117t detection limits, 183t kinetic studies, 226 physical properties, 123t Setschenow constant, 90 Benzo[a]pyrene, 72, 214, 285 Benzo[b]fluoranthene, 293 Benzoic acid. 43-44

Benzophenone-3, 131t Benzovlacetone: as SME solvent, 119t physical properties, 125t Benzyl alcohol: as SME solvent, 33, 118t physical properties, 123t Beverages, 198, 211-215 Bioactive plant components, 283 Biological fluids, 11, 206-207 Biomonitoring, 204 Blood, 23, 175, 204, 205t, 206 plasma, 62, 103, 175, 205t, 206 serum, 23, 175, 205t, 206 Bovine milk, 214 Bovine serum albumin, 225 4-Bromofluorobenzene as internal standard, 69, 78, 269 BTEX, 173, 179, 220, 222, 226, 266, 267-268, 293 1-Butanol. as SME solvent, 118t physical properties, 123t Butyl acetate: as SME solvent, 119t physical properties, 124t polarity index, 121 1-Butyl-3-methylimidazolium hexafluorophosphate: as SME solvent, 120t physical properties, 125t Cadmium, 11, 196, 197t Caffeine, 214 Calibration, 14 curve, 150, 151 external, 150, 175 methods, 62-63 Capillary electrophoresis, 29, 34, 80, 114, 127, 142, 194, 198 Carbon disulfide: as SME solvent, 11, 24, 69, 120t, 291 physical properties, 126t Carbon tetrachloride: as analyte, 219 as SME solvent, 11, 24, 69, 115, 117t, 121, 291 physical properties, 97t, 122t Carbonyl compounds, 109, 110, 112t, 211 Carboxylic acids, see Acids, carboxylic Carrier-mediated transport, 60-61, 105, 174, 195 Carryover, 7, 78, 105 Centrifugation, 22, 115, 175 Certified reference materials, 175 Chlorinated hydrocarbons: as SME solvents, 117t physical properties, 122-123t

Chlorobenzene: as analyte, 273f, 277 as SME solvent, 11, 69, 117t, 121 physical properties, 123t Chlorobenzenes, as analytes, 131t, 273f, 292f Chloroform: as analyte, 30, 218, 219, 269-270, 273f, 277 as SME solvent, 97, 117t physical properties, 97t, 122t polarity index, 121 Chlorophenols, 109, 192, 204 derivatization, 112t extraction-derivatization, 195 Chromium, 196, 197t Cleanup, see Sample cleanup Clinical analysis, 204-211 Cloud point extraction, 305 Clove buds, 212 Cobalt, 196, 197t Cocaine, 207 Coffee, 213t, 214 CombiPal autosampler, 109, 222 Consolute solvent volume, 130t Consumer products, 216-220 Continuous flow microextraction, 103, 114, 115, 191, 306-307 Convection, 46, 47, 51, 54, 58, 59, 60 Convective-diffusive mass transfer, 47-48, 51 Copper, 130t, 196 Cosmetics, 217t CRM. see Certified reference material Cyanide: free, 198 weak acid dissociable, 198 Cycle Composer software, 109, 222 Cycle flow microextraction, 306-307 B-Cyclodextrin, 34, 286, 287 Cyclohexane: as analyte, 277 as SME solvent, 116t, 121 physical properties, 122t Cyclopentane: as SME solvent, 116t physical properties, 122t p-Cymene: as SME solvent, 118t, 187, 212 physical properties, 123t

DDTC, see Diethyldithiocarbamate Decafluorobiphenyl, as internal standard, 69, 263, 269 Decane: as SME solvent, 69, 115, 116t

impurity in tetradecane, 263 physical properties, 32t, 78t, 122t Derivatization, 109-113 acetylation, 112t, 194 alkylation, 112t, 194 complexation, 113 concurrent with extraction, 111 esterification, 112t, 185 hydrazone formation, 112t, 186 in-drop, 111 in-fiber, 111 in-injection port, 112 in-sample, 111 in-syringe, 111 in-vial. 111 iodination, 112t mechanistic aspects, study of, 226-228 oxime formation, 185-186, 287-288 pentafluorobenzylation, 185-186 postextraction, 111-113 preextraction, 110-111 Schiff base reaction, 112t silulation, 112t, 186, 195 summary of reactions, 112t tosylation, 112t Detection limit: instrument, 150 method, 150 Detection limits: for metals, 197t for pesticides, 203t for priority pollutants, 183t Detector: electron capture, 32, 80, 110, 114, 127, 184 flame ionization, 80, 127 flame photometric, 127 mass spectrometric, 80, 127 nitrogen-phosphorus, 127 pulsed discharge helium ionization, 207 **UV/VIS, 127** o-Dibutyl phthalate: as SME solvent, 119t physical properties, 124t Dibutyl phthalate: as analyte, 218 as SME solvent, 118t physical properties, 124t 1,2-Dichlorobenzene: as analyte, 273f, 292f as SME solvent, 117t physical properties, 122t 1.2-Dichloroethane: as SME solvent, 117t physical properties, 122t

Dichloromethane: as analyte, 220, 277 as SME solvent, 117t physical properties, 122t Dielectric constant, 40, 121 Diethyl phthalate: as analyte, 218 physical properties, 78t Diethyldithiocarbamate, 197, 197t Diffusion, 46, 47 Diffusion coefficient, 46, 51, 52, 55, 56, 58, 62, 105.115 Diffusive mass transfer, 46-47 Dihexyl ether: as SME solvent, 119t, 121, 194 physical properties, 124t Diisobutyl ketone: as SME solvent, 119t physical properties, 125t Diisocyanates, 110, 130t, 172 Dimethylformamide: as SME solvent, 120t physical properties, 126t Dinitrophenols, 130t, 193 2,4-Dinitrophenylhydrazine, 287 Dioxane, 277 Dipole moment, 40 Direct immersion microextraction, 21, 22-30, 69, 72, 114, 121, 174, 209 solvents used, 115 Direct on-line coupling, 201, 203, 222, 223 Directly suspended droplet microextraction, 115, 138, 142, 143, 144, 307 Disperser solvent, 111 volume, 132t, 141 Dispersive liquid-liquid microextraction, 9, 11, 22, 24-25, 31, 69, 76, 103, 174, 291-292, 305-306 and derivatization. 111 calculation examples, 87-89 extractant volume, 212 solvents used, 121 Distribution coefficient, see Distribution constant Distribution constant, 38, 59, 60, 63, 107 effect of ionic strength, 42 effect of temperature, 41-42 DLLME, see Dispersive liquid-liquid microextraction Dodecane: as SME solvent, 115, 116t, 261 physical properties, 78t, 122t Dodecyl acetate: as SME solvent, 119t physical properties, 124t

Donor phase, 60, 62 Drain water, 181t Drinking water, 180t, 269-270 Drop dissolution, 40, 114 Drop volume, 114, 202, 262, 263 optimization, 130t Drop-to-drop microextraction, 23, 103, 207, 214, 307 Drug-protein binding, 224-226 Drugs: anabolic steroids, 110 analgesics, 209 antacids, 209 antiarrhytmics, 209 antibiotics, 209 anticoagulants, 209 antidepressant, 209 antidiarrheal agents, 209 antiemetics, 209 antiepileptic, 209 antihistamines, 209 antiinflammatory, see NSAIDs antimalarial, 209 antinauseants, 209 antiparasitic, 209 antitussives, 209 basic. 105 β-blockers, 209 bronchodilators, 209 coronary therapeutics, 209 decongestants, 209 diuretics, 209 gastrointestinal, 209 H1 antagonists, 209 H₂ antagonists, 209 illicit, 209 local anesthetics, 209 polar, 468 psychoactive, 209 uricosurics, 209 Dust. 182t Dynamic SME, 13, 22, 31-32, 69, 74-75, 107-108, 182, 292-295 model, 54-55, 56 optimization, 149-150 typical parameters, 133t Edible oils, 174, 211, 213t, 214, 219 Electromembrane extraction, 29, 62, 105, 208, 309-310 preferred solvents, 115 Endocrine disruptors, 111, 189 Engine oil, 174, 217t, 220, 264-267 Enrichment factor, 60, 127, 152

Environmental applications of SME, 178--204 Environmental samples, 178-179 Equilibration time, 142-143 Equilibria: multiphase, in matrix, 223 multiple, 175 Equilibrium: amount of analyte extracted, 86, 91, 95 analyte concentration in organic phase, 39, 50 distribution isotherm, 38 drug-protein, 224-226 extraction, 106, 107 in dynamic SME, 55 solvent losses, 44 Essential oil components, 130t Esters: as analytes, 185, 211, 212 as SME solvents, 119t physical properties, 124t Ethanol: as analyte, 220, 282 as disperser solvent, 11 Ethers: as SME solvents, 119t physical properties, 124t Ethyl acetate: as analyte, 212 as SME solvent, 119t, 201 physical properties, 124t Ethylbenzene: as analyte, 59, 173, 179, 264-266, 267-268, 273f detection limits. 183t kinetic studies, 226 Ethylene glycol: as SME solvent, 118t physical properties, 124t Exhaustive extraction, 39, 51, 106, 111, 138, 173 Experimental design: application in SME, 127-131 Box-Behnken design, 128, 130t central composite design, 128, 130t Doehlert design, 128, 130t D-optimal design, 128 factorial design, 129, 131t fractional factorial design, 129, 130-131t mixed-level factorial design, 131t mixed-level orthogonal array design, 131t modified simplex optimization, 129, 130t multifactorial screening, 130t orthogonal array design, 131t Plackett-Burman design, 129, 130-131t response surface modelling, 128, 130t

three-variable Doehlert matrix design, 130t type III screening, 130t Extractions: classical and SME, comparison of, 20 efficiency, 30 equipment requirements, 20 kinetics, 226 liquid-liquid, 3, 13 liquid-solid, 5 micro liquid-liquid, 4-5 mode, selection of, 102-107 modes, 21-31 optimization of parameters, 129, 134-150 parameters, 21, 261-264, 262t parameters, typical ranges, 132-133t rate, 50, 51, 59, 60, 63 solid phase, 5-6, 14 solvent selection, 32-34, 40, 69, 113-121 solvents, 32-34, 76-78 temperature, 30, 31, 41-42, 63, 83-84 time, 27, 29, 30, 31, 83-84, 105, 173 time profile, 55, 108 Fat-soluble vitamins, 131t Fatty acids, see Acids, fatty Fiber length, 133t, 148-149 Fiber preparation, 26, 289-290 Fick's law, 46-47 Field sampling, 8, 107, 111, 171, 173, 189, 221-222 Film theory, 51-52, 226 Filtration 175 Final determination method, selection of, 121, 127 Fish, 182t Flame ionization detector, see Detector, flame ionization Flame photometric detector, see Detector, flame photometric Flavor components, 212, 213t Flow injection analysis, 5 Food analysis, 31, 211-215, 215t Food dyes, 211 Food flavorings, 8 Food simulants, 218 Forensic analysis, 204-211 Formaldehyde, 205, 211, 227 Fresh water, 180t Fruit juice, 213t, 214 Fruits, 176, 198, 211, 213t, 214 Gas chromatography, 80, 105, 113, 121, 141 high speed, 154 Gaseous matrices, 171-174

Gaseous samples, 102, 173–174

Gasoline: as arson accelerant, 281 in engine oil, 31, 220, 264-267 GC interface for ionic liquids, 121, 127 Glycerol: as SME solvent, 118t physical properties, 124t Groundwater, 180t Hair, 176, 204, 205t, 207 Halocarbons, 34 Halogenated alkanes, 72 Halogenated anisoles, 211 Halogenated compounds, 110, 272, 291-292 Setschenow constant, 90 Halogenated disinfection by-products analysis of, 269-271 Halogenated solvents, 32 Halogen-containing anions, 198 Headspace extraction static, calculation examples, 95-97 Headspace SME, 9, 21, 30-31, 41, 42, 69, 72, 102, 113, 308 calculation examples, 91-93 concurrent extraction-derivatization, 111 coupled with hydrodistillation, 176-177 gas sampling, 171-173 general mass transfer model, 56-60 hollow fiber-protected, 31, 172, 308-309 kinetic studies, 226 liquid sampling, 174 mechanistic studies of in-drop derivatization, 226-228 solid sampling, 176 solvent requirements, 114 solvents used, 78t, 115 temperature effect, 42 Headspace water-based SME, 187 Heavy metals, 196, 204 Henry's law constant, 12, 30, 41, 56, 63, 71, 91 Heptadecane: as SME solvent, 116t physical properties, 122t Heptane: as SME solvent, 116t physical properties, 122t 1-Heptanol: as SME solvent, 118t physical properties, 123t 2-Heptanone: as SME solvent, 119t physical properties, 125t Herbicides: acidic, 198 amides, anilides, and thiocarbamates, 201

chloroacetanilides, 202 phenoxy acids, 201 triazines, 200-201, 214 Hexadecane: as SME solvent, 25, 34, 69, 115, 261, 264-266, 269.272 physical properties, 78t, 122t Hexane: as analyte, 218 as SME solvent, 115, 116t, 261 physical properties, 122t 1-Hexanol: as SME solvent, 119t physical properties, 123t Hexyl acetate: as SME solvent, 119t physical properties, 124t 1-Hexyl-3-methylimidazolium hexafluorophosphate: as SME solvent, 120t physical properties, 125t High-performance liquid chromatography, 29, 80, 114, 127, 142, 194 Hildebrand solubility parameter, 40 Hollow fiber-protected SME, 10, 70, 75-76, 102 - 103calculation examples, 87-89 model for, 55-56 Hollow fiber-protected three-phase SME, 10, 28-30, 69, 105, 127, 174, 309 dynamic mode, 231 preferred solvents, 115, 121 Hollow fiber-protected two-phase SME, 9, 10, 25-28, 103, 174, 307-308 preferred solvents, 115, 121 Homogeneous liquid-liquid extraction, 111, 190, 306 Honey, 212, 213t Hot water extraction. see Pressurized hot water extraction Hydrazones, 186 Hydride generation, 113 Hydrodistillation, 176-177, 216 Hydrogen bonding, 12, 34 Hydrophilic analytes, 105, 111, 174 Hydrophobic analytes, 62, 105 adsorption on container walls, 154 Hydrophobic drug-protein interactions, 206 Hydrophobic effect, 40 Hydrophobic ion-pairing reagent, 105 Hydrophobic membranes in SME, 148 Hydrophobicity, octanol-water partition coefficient as a measure of, 229 Hydroxyketones, 186 8-Hydroxyquinoline, 197t

Inductively coupled plasma, 127 Industrial effluent, 181t Industrial hygiene, 222 Injection volume, 261 Inorganic anions, 109, 198 Inorganic compounds, 109, 127, 198 Instrument detection limit, see Detection limit, instrument Internal standard, 34, 69, 150, 176 Iodine, as derivatizing agent, 194 lonic liquids: as SME solvents, 79, 109, 120t, 121, 187. 223 physical properties, 125t Ionic strength, 42, 63, 82 effect on HS-SDME, calculations, 93-95 effect on SDME, calculations, 89-91 effect on solvent water solubility, 97-98 Isooctane: as SME solvent, 116t, 121 physical properties, 122t 1-Isopropyl-4-nitrobenzene: as SME solvent, 120t physical properties, 126t Isotopic dilution, 150, 176 Ketones: as analytes, 109, 185 as SME solvents, 119t derivatization, 112t physical properties, 125t Setschenow constant, 90 Kinetics, 46-62 experimental results, 226 three-phase, 56-62 two-phase, 49-56 Kown see Octanol/water partition coefficient Landfill leachate, 181t Large-volume injection, 88, 105, 141 Lcad, 196, 197t Limit of detection. see Detection limit Limit of quantitation, 151 Linear dynamic range, 151 Liquid food simulants, 217t Liquid-gas-liquid microextraction, 304, 309 Liquid matrices, see Liquid samples Liquid samples, 174-176 Liquid-liquid extraction, see Extraction, liquid-liquid Liquid-liquid-liquid microextraction, 22, 69, 105, 127, 193-194, 209, 309 mass transfer in, 60 Liquid-phase microextraction, 10, 21, 307

LLLME, see Liquid-liquid-liquid microextraction LPME, see Liquid-phase microextraction MALDI, see Matrix-assisted laser desorption/ionization MASE, see Membrane-assisted solvent extraction Mass spectrometry, 113, 127, 176 Mass transfer, see Convective-diffusive mass transfer Matrix effects, 62, 153, 175, 282 Matrix modification, 214 Matrix-assisted laser desorption/ionization, 127, 221 Membrane-assisted solvent extraction, 105, 109, 174, 191, 310 Mercury, 196, 197t Metacrate, 131t Metal ions, 109, 111, 127, 196-197, 207 Metalloids, 109, 113, 127, 196-197 Metals, 113 detection limits, 197t Methanol: as analyte, 220, 277, 282 as disperser solvent, 24 as drug-protein interaction suppressor, 206 as esterification reagent, 185 as extracting solvent, 177, 207 as HPLC solvent, 34 as volatile release agent, 31 Method detection limit, see Detection limit, method Methyl tert-butyl ether, 4, 189 Methylmercury hydride, 197 N-Methylpyrrolidone: as SME solvent, 120t physical properties, 126t Microdrop, 21, 30, 33, 45, 79-80, 172, 177 Microporous membrane liquid-liquid extraction, 200-201, 202, 308 Microsyringe, 54, 70, 79-80, 103, 114, 121, 172, 173.174 Microwave distillation, 216 Microwave-assisted extraction, 178, 216 Milk, 204, 208, 211, 213t Milk powder, 176 MMLLE, see Microporous membrane liquid-liquid extraction Mycotoxins, 211, 214 Naphthalene, 87t, 88t, 91t, 93t, 94 Setschenow constant, 90

Needle, microsyringe, 24

Negligible depletion SME, 225, 230

Nickel, 196, 197t Nicotine, 172, 173, 215 Nitrophenols, 173, 192 2-Nitrophenyl octyl ether, 62 as SME solvent, 119t physical properties, 125t 4-Nitro-m-xylene: as SME solvent, 120t physical properties, 126t Non-alcoholic beverages, 211, 213t Nonane, as SME solvent, 116t 1-Nonanol: as SME solvent, 118t physical properties, 124t Non-exhaustive extraction, 179, 224 Nonporous membranes, 7, 148, 149 NSAIDs, 131t O-2,3,4,5,6-(Pentafluorobenzyl)hydroxylamine, 110, 185-186, 211 OCPs, see Pesticides, organochlorine Octane: as SME solvent, 116t physical properties, 78t, 122t 1-Octanol, 29, 31, 32t, 33, 34, 69, 115, 121, 261, 269, 281 as SME solvent, 118t physical properties, 32t, 78t, 118t, 124t solubility in water, 97t Octanol/water distribution constant, 85 Octanol/water partition coefficient, 32, 41, 63, 71,82 determination by SME, 229-230 1-Octyl-3-methylimidazolium hexafluorophosphate: as SME solvent, 120t physical properties, 125t Off-line analysis, 308 On-line coupling, 201, 308 On-line preconcentration, 192 OPPs, see Pesticides, organophosphorus Optimization: agitation method and rate, 132t, 147-148 dynamic mode parameters, 133t, 149-150 dwelling time, 133t, 150 extraction time, 132t, 142-144 general recommendations, 69-70 headspace volume, 69, 132t, 134, 137 ionic strength, 132t, 146 number of cycles, 55, 133t, 149-150 pH of sample and acceptor solution, 132t, 145-146 plunger motion rate, 133t, 149-150 sample and solvent temperature, 132t, 144-145

sample flow rate, 132t, 142 sample volume, 69, 78-79, 129, 132t, 134 SME parameters, 183 solvent volume, 132t, 137, 141-142 water and organic volume, 51 Optimization method: one-variable-at-a-time, 128 response surface methodology, 128 selection, 127-129 simplex design, 129 Optimization methods, applications in SME, 130-131t Organic acids, see Acids, organic Organic solvents: in pharmaceuticals, 218, 276-281 physical properties, 122-126t Organomanganese compounds, 196 Organomercury compounds, 196 Organometallic compounds, 109, 196-197 derivatization, 111 Organotin compounds, 196 Oxime formation, see Derivatization, oxime formation PAHs, see Polycyclic aromatic hydrocarbons Palladium, 196, 197t Partition coefficients, 41, 113 PBDEs, see Polybrominated diphenyl ethers PCBs, see Polychlorinated biphenyls Penetration theory, 53 Pentafluorobenzaldehyde, 110 I-Pentanol: as SME solvent, 118t physical properties, 123t Peptides, 110 Persistent organic pollutants, 189 Personal care products, 174 Pesticide residues, 169 Pesticides, 130t, 198-204, 211, 214, 288-291 carbamates, 200 detection limits, 203t fungicides, 201-202 organochlorine, 198-199, 214, 216 organonitrogen, 202 organophosphorus, 199-200, 214 organosulfur, 202 phenylureas, 202 pyrethroids, 200 PFBAY, see Pentafluorobenzaldehyde PFBHA, see O-2,3,4,5,6-(Pentafluorobenzyl) hydroxylamine pH, 28, 106, 192-193 Pharmaceuticals, 7, 29, 31, 217t, 216-220, 276-281

Pharmacokinetics, 228 Phase ratio, 39, 107, 151, 152 Phase-transfer catalysis, 111 Phenolic compounds, 212 derivatization, 112t Phenolic endocrine disruptors, 210 Phenols, 105, 192 derivatization, 109, 111 detection limits, 183t Setschenow constant, 90 Phenoxy acids, see Herbicides, phenoxy acids Phenylhexane: as SME solvent, 118t physical properties, 123t Phthalate esters, see Phthalates Phthalates, 130t, 189, 217-218 detection limits, 183t Physical properties of solvents, 122-126t Physicochemical applications of SME, 223-230 Plant parts, 215-216, 215t buds, 212, 215, 215t flowers, 215, 215t leaves, 215, 215t, 216 needles, pine, 182t roots, 215, 215t seeds, 215, 215t Plasma, see Blood, plasma Polar analytes, 28, 40, 60, 174 Polar volatiles, 185-189 Polarity index, 40, 121 Polyamines, 205, 211 Polybrominated diphenyl ethers, 189, 204, 210 Polychlorinated biphenyls, 189, 204, 210, 214 detection limits, 183t Setschenow constant, 90 Polychlorinated hydrocarbon solvents, detection limits, 183t Polycyclic aromatic hydrocarbons, 189, 216, 222, 284-287, 291-292 detection limits, 183t Setschenow constant, 90 Polystyrene, 176, 217t Porous membranes, 148-149 Potato chips, 212, 213t Precision, 152-153 inter-day, 152 interlaboratory, 153 intermediate, 152 intra-assay, 152 intra-day, 152 Preconcentration, 63 kinetics, 60 Pressurized hot water extraction, 177, 216

Protein precipitation, 175 Proteins, as matrix components, 44, 224 Purge-and-trap, 3, 6-7, 106, 184 Pyrene: as analyte, 87t, 88t, 91t, 93t, 94t Setschenow constant, 90 Pvridine: as analyte, 218, 277 as SME solvent, 120t physical properties, 125t 1-(2-Pyridylazo)2-naphthol, 197t Quantitation methods, 150 Rainwater, 180t, 186 Rate-determining step, 50, 115, 226 Recovery: absolute, 153 relative, 153 Repeatability, 152 Representative sample, 189 Reproducibility, 153 Residual solvents, 6, 7, 211, 218-220, 276-281 Reverse-phase HPLC, 34, 127 Robustness, 153 Rohrschneider polarity scale, 121 Ruggedness, 152 Saliva, 204, 205t, 207 Salt, 212, 213t Salted eggs, 212, 213t, 214 Salting out, 146 Sample cleanup, 15, 62, 63, 105, 121 Sampling: air, 171-174 solids, 176-178 water, 174-176 Sauces, 211, 213t, 214 SDME, see Single drop microextraction Seawater, 181t Sediment, 176, 182t, 189, 198 Selectivity, 154 Selcnium, 130t, 196 Semivolatiles, 22, 33, 56 nonpolar, 69, 103, 189-192 polar, 105, 109-110, 192-196 Sensitivity, 85, 151-152 Serum, see Blood serum Sewage, 181t Short-chain fatty acids, 131t Silicone oil AR 20 as SME solvent, 120t physical properties, 126t Silver, 196, 197t

Single drop microextraction, 9, 21, 72, 103, 111, 114.307 calculation examples, 84-87 Sodium tetrahydroborate, 197 Soil, 176, 182t, 189, 198, 287-291 Solvation, 40 Solvent bar microextraction, 22, 28, 308 Solvent selection. see Extraction, solvent selection Solvent evaporation, 44-45 Solvent solubility in water, 44-45, 97-98 Solvent volume, see Optimization, solvent volume Speciation, 42-44, 63 Spirits, 174, 213t Standard addition, 150, 175 Standard deviation, 109, 152 Standard reference materials, 153, 175 Static extraction, 107-108 Static headspace analysis, 6, 7, 14 calculation examples, 95-97 Sudan dyes, 214 Sugarcane juice, 214 Summa canisters, 171 Supported liquid membrane microextraction, 11, 22, 149, 304 Surface tension, 114 Surface water, 180t Surfactants, 189, 305 Surrogate standards, 34 Tap water, 175, 180t Tea. 213t Tedlar bags, 171 Temperature, see Extraction, temperature Temperature-controlled ionic liquid-dispersive liquid-phase microextraction, 306 Tetrabutylammonium bromide, 194 Tetrabutylammonium hydrogen sulfate, 196 1,1,2,2-Tetrachloroethane: as SME solvent, 117t physical properties, 123t Tetrachloroethane: as SME solvent, 117t physical properties, 122t Tetrachloroethene: as analyte, 183, 219 as SME solvent, 11, 69, 117t, 291 physical properties, 32t, 123t Tetradecane: as internal standard, 264 as SME solvent, 34, 69, 116t, 261, 269, 272, 291 physical properties, 32t, 78t, 122t solubility in water, 97t Tetrahydrofuran, as analyte, 220

Tetraspirocyclohexylcalix[4]pyrrole, 197t Thermodynamics of SME, 37-45 THMs, see Trihalomethanes Time. see Extraction, time Tin hydride, 197 Tobacco smoke, 172, 173, 182t Toluene: as analyte, 7, 12, 59, 173, 179, 264-266, 267-268, 273-275 as SME solvent, 31, 33, 69, 114, 115, 117t, 121.261 detection limits, 183t kinetic studies, 226 physical properties, 32t, 78t, 123t polarity index, 121 solubility in water, 97t TOPO, see Trioctylphosphine oxide 2,4,6-Tribromoanisole, 130t Tributyl phosphate: as SME solvent, 119t physical properties, 124t 2.4.6-Trichloroanisole, 130t 1,2,4-Trichlorobenzene: as SME solvent, 117t physical properties, 123t 1,1,1-Trichloroethane: as analyte, 219 as SME solvent, 117t physical properties, 123t Trichloroethane, as analyte, 183 Trichloroethene, as analyte, 183, 277 2,4,6-Trichlorophenylhydrazine, 110, 186, 211, 227 Tridecane: as internal standard, 263 as SME solvent, 116t, 261 physical properties, 122t 1,1,1-Trifluoroacetylacetone, 197t Trihalomethanes, 4, 131t, 155, 183, 222, 269-271 Trioctylphosphine oxide, 200, 201, 224 Triolein: as SME solvent, 119t, 173 physical properties, 124t Ultra performance liquid chromatography, 154 Ultrasound-assisted emulsificationmicroextraction, 218, 306 Ultrasound-assisted extraction, 203, 216 Undecane: as SME solvent, 116t physical properties, 78t, 122t 1-Undecanol, 24, 69 as SME solvent, 118t physical properties, 32t, 124t

6-Undecanone: as SME solvent, 119t physical properties, 125t Uranium, 196, 197t Urine, 23, 62, 175, 206 U.S. EPA Method 524.2, 7, 184, 272 U.S. EPA Method 525.2, 5 U.S. EPA Method 551.1, 4, 155t, 269 U.S. EPA Method 624, 6 U.S. EPA Method 625, 4 U.S. EPA method detection limits: heavy metals, 197t pesticides, 203t U.S. Pharmacopeia Method 467, 6, 7-8, 276 UV/VIS spectrophotometry, 127 Validation, 154-155, 175 Vegetables, 176, 198, 212, 213t, 214 Verification, 154-155 Vitamins, 219, 220 Vodka, 174, 213t Volatile basic tobacco components, 215 Volatile flavor components, 211 Volatile halocarbons, 183-185, 218 Volatile hydrocarbons, 179, 182, 218 Volatile organic compounds, 215 SME analysis, 2151, 271-276 Volatile organic solvents, 218 Volatile phenols, 211, 212 Volatile polar solvents, 185-189

Volatile sulfur compounds, 212 Vortex device, 82, 262 Wastewater, 4, 6, 175, 181t Water: as extractant, 177 as SME solvent, 120t, 187 physical properties, 78t, 125t Water analysis, 174-176 Well water, 175, 180t Whole blood, see Blood Wine, 212, 213t, 214 *m*-Xylene: as analyte, 266, 267, 277 as SME solvent, 117t physical properties, 123t o-Xylene: as SME solvent, 69,117t physical properties, 32t, 78t, 123t Xylene: as analyte, 59, 218 as SME solvent, 69 kinetic studies, 226 polarity index, 121 Xylenes: as analytes, 7, 173, 179, 267–268 as SME solvents, 12, 118t detection limits, 183t physical properties, 122t