Contents

Preface ..... **xi**

1. Introduction **1**
Maintaining a Laboratory Notebook 5

2. Laboratory Safety **9**
Laboratory Safety Rules We Recommend 10

3. Equipping a Home Chemistry Lab **13**
General Purpose Glassware and Plasticware 14
Volumetric Glassware 22
Microscale Equipment 26
Recommended Laboratory Glassware 28
Laboratory Equipment and Supplies 30
Work Area 41

4. Chemicals for the Home Chemistry Lab **45**
Chemical Names 46
Chemical Grades 47
Chemical Risk Factors and Safety Advice 48
Hazard Pictograms and Letter Symbols 52
Safe Chemical Handling 52
Chemicals Used In This Book 58

5. Mastering Laboratory Skills **69**
Measurement Resolution and Significant Figures 69
Handling Chemicals Properly 71
Using a Balance 73
Measuring Liquids by Volume 74
Filtration 83
Separations 84
Using Heat Sources 85
Working with Glass Tubing 88
Cleaning Glassware 90

6. Laboratory: Separating Mixtures 93
Laboratory 6.1: Differential Solubility: Separate Sand and Sucrose 94
Laboratory 6.2: Distillation: Purify Ethanol 97
Laboratory 6.3: Recrystallization: Purify Copper Sulfate 101
Laboratory 6.4: Solvent Extraction 105
Laboratory 6.5: Chromatography: Two-Phase Separation of Mixtures 108
Laboratory 6.6: Determine the Formula of a Hydrate 116

7. Laboratory: Solubility and Solutions 121
Laboratory 7.1: Make Up a Molar Solution of a Solid Chemical 126
Laboratory 7.2: Make Up a Molal Solution of a Solid Chemical 133
Laboratory 7.3: Make Up a Molar Solution of a Liquid Chemical 136
Laboratory 7.4: Make Up a Mass-to-Volume Percentage Solution 140
Laboratory 7.5: Determine Concentration of a Solution by Visual Colorimetry 142

8. Laboratory: Colligative Properties of Solutions 147
Laboratory 8.1: Determine Molar Mass by Boiling Point Elevation 149
Laboratory 8.2: Determine Molar Mass by Freezing Point Depression 153
Laboratory 8.3: Observe the Effects of Osmotic Pressure 156

9. Laboratory: Introduction to Chemical Reactions and Stoichiometry 161
Laboratory 9.1: Observe a Composition Reaction 163
Laboratory 9.2: Observe a Decomposition Reaction 167
Laboratory 9.3: Observe a Single Displacement Reaction 171
Laboratory 9.4: Stoichiometry of a Double Displacement Reaction 175

10. Laboratory: Reduction-Oxidation (Redox) Reactions 181
Laboratory 10.1: Reduction of Copper Ore to Copper Metal 183
Laboratory 10.2: Observe the Oxidation States of Manganese 186

11. Laboratory: Acid-Base Chemistry 191
Laboratory 11.1: Determine the Effect of Concentration on pH 193
Laboratory 11.2: Determine the pH of Aqueous Salt Solutions 198
Laboratory 11.3: Observe the Characteristics of a Buffer Solution 200
Laboratory 11.4: Standardize a Hydrochloric Acid Solution by Titration 204

12. Laboratory: Chemical Kinetics 211
Laboratory 12.1: Determine the Effect of Temperature on Reaction Rate 212
Laboratory 12.2: Determine the Effect of Surface Area on Reaction Rate 216
Laboratory 12.3: Determine the Effect of Concentration on Reaction Rate 219
Laboratory 12.4: Determine the Effect of a Catalyst on Reaction Rate 223

13. Laboratory: Chemical Equilibrium and Le Chatelier's Principle 229
Laboratory 13.1: Observe Le Chatelier's Principle in Action 231
Laboratory 13.2: Quantify the Common Ion Effecct 236
Laboratory 13.3: Determine a Solubility Product Constant 239

14. Laboratory: Gas Chemistry 245
Laboratory 14.1: Observe the Volume-Pressure Relationship of Gases (Boyle's Law) 248
Laboratory 14.2: Observe the Volume-Temperature Relationship of Gases (Charles' Law) 253
Laboratory 14.3: Observe the Pressure-Temperature Relationship of Gases (Gay-Lussac's Law) 257
Laboratory 14.4: Use the Ideal Gas Law to Determine the Percentage of Acetic Acid in Vinegar 260
Laboratory 14.5: Determine Molar Mass From Vapor Density 264

15. Laboratory: Thermochemistry and Calorimetry 269
Laboratory 15.1: Determine Heat of Solution 271
Laboratory 15.2: Determine the Heat of Fusion of Ice 274
Laboratory 15.3: Determine the Specific Heat of a Metal 276
Laboratory 15.4: Determine the Enthalpy Change of a Reaction 280

16. Laboratory: Electrochemistry 285
Laboratory 16.1: Produce Hydrogen and Oxygen by Electrolysis of Water 287
Laboratory 16.2: Observe the Electrochemical Oxidation of Iron 291
Laboratory 16.3: Measure Electrode Potentials 294
Laboratory 16.4: Observe Energy Transformation (Voltage and Current) 298
Laboratory 16.5: Build a Voltaic Cell with Two Half Cells 301
Laboratory 16.6: Build a Battery 304

17. Laboratory: Photochemistry 309
Laboratory 17.1: Photochemical Reaction of Iodine and Oxalate 310

18. Laboratory: Colloids and Suspensions 317
Laboratory 18.1: Observe Some Properties of Colloids and Suspensions 321
Laboratory 18.2: Produce Firefighting Foam 324
Laboratory 18.3: Prepare a Gelled Sol 326

19. Laboratory: Qualitative Analysis 331
Laboratory 19.1: Use Flame Tests to Discriminate Metal Ions 332
Laboratory 19.2: Use Borax Bead Tests to Discriminate Metal Ions 336
Laboratory 19.3: Qualitative Analysis of Inorganic Anions 339
Laboratory 19.4: Qualitative Analysis of Inorganic Cations 343
Laboratory 19.5: Qualitative Analysis of Bone 349

20. Laboratory: Quantitative Analysis 355
Laboratory 20.1: Quantitative Analysis of Vitamin C by Acid-Base Titration 356
Laboratory 20.2: Quantitative Analysis of Chlorine Bleach by Redox Titration 360
Laboratory 20.3: Quantitative Anion Analysis of Seawater 365

21. Laboratory: Synthesis of Useful Compounds 373
Laboratory 21.1: Synthesize Methyl Salicylate from Aspirin 374
Laboratory 21.2: Produce Rayon Fiber 380

22. Laboratory: Forensic Chemistry 385
Laboratory 22.1: Use the Sherlock Holmes Test to Detect Blood 386
Laboratory 22.2: Perform a Presumptive Test for Illicit Drugs 389
Laboratory 22.3: Reveal Latent Fingerprints 395
Laboratory 22.4: Perform the Marsh Test 399

Index 405