Contents

Series Preface xiii

Preface xv

About the Author xvii

Acronyms, Abbreviations and Symbols xix

1 The Chemistry of Forensic Evidence 1

1.1 Introduction 1
1.2 Evidence Types 2
1.2.1 Polymers 2
1.2.2 Fibres 6
1.2.3 Paint 7
1.2.4 Documents 9
1.2.5 Glass 10
1.2.6 Soil 11
1.2.7 Explosives 12
1.2.8 Firearms 14
1.2.9 Arson 14
1.2.10 Body Fluids 16
1.2.11 Drugs and Toxicology 16
1.2.12 Fingerprints 21
1.3 Introduction to Data Analysis 23
1.4 Summary 24
References 24

2 Preliminary Tests 27

2.1 Introduction 27

2.2 Chemical Tests 27
2.2.1 Methods 28
2.2.2 Drugs and Toxicology 28
2.2.3 Body Fluids 29
2.2.4 Gunshot Residue 30
2.2.5 Explosives 31
2.2.6 Paint 31
2.2.7 Documents 32
2.3 Density 32
2.3.1 Methods 32
2.3.2 Glass 33
2.3.3 Soil 33
2.3.4 Polymers 34
2.4 Light Examination 35
2.4.1 Methods 35
2.4.2 Fingerprints 36
2.4.3 Body fluids 38
2.4.4 Documents 38
2.5 Summary 39
References 39

3 Microscopic Techniques 41

3.1 Introduction 41
3.2 Optical Microscopy 42
3.2.1 Methods 42
3.2.2 Interpretation 44
3.2.3 Fibres 45
3.2.4 Paint 48
3.2.5 Drugs 49
3.2.6 Glass 49
3.2.7 Soil 50
3.2.8 Documents 51
3.2.9 Firearms 51
3.3 Transmission Electron Microscopy 51
3.3.1 Method 52
3.3.2 Interpretation 53
3.3.3 Paint 53
3.4 Scanning Electron Microscopy 54
3.4.1 Methods 54
3.4.2 Interpretation 55
3.4.3 Gunshot Residue 56

3.4.4 Paint 57
3.4.5 Fibres 58
3.4.6 Documents 58
3.4.7 Glass 59
3.5 Atomic Force Microscopy 59
3.5.1 Methods 59
3.5.2 Interpretation 60
3.5.3 Documents 60
3.6 X-Ray Diffraction 60
3.6.1 Methods 62
3.6.2 Interpretation 63
3.6.3 Explosives 63
3.6.4 Paint 63
3.6.5 Drugs 64
3.6.6 Documents 65
3.6.7 Soil 65
3.7 Summary 66
References 66

4 Molecular Spectroscopy 69

4.1 Introduction 70
4.2 Infrared Spectroscopy 70
4.2.1 Methods 70
4.2.2 Interpretation 73
4.2.3 Paint 74
4.2.4 Fibres 75
4.2.5 Polymers 82
4.2.6 Documents 85
4.2.7 Explosives 86
4.2.8 Drugs 87
4.3 Raman Spectroscopy 89
4.3.1 Methods 90
4.3.2 Interpretation 91
4.3.3 Drugs 91
4.3.4 Paint 93
4.3.5 Fibres 94
4.3.6 Documents 94
4.3.7 Explosives 94
4.4 Ultraviolet–visible Spectroscopy 95
4.4.1 Methods 95
4.4.2 Interpretation 97

4.4.3 Fibres 97
4.4.4 Paint 98
4.4.5 Documents 99
4.4.6 Drugs 99
4.4.7 Toxicology 101
4.5 Fluorescence Spectroscopy 101
4.5.1 Methods 101
4.5.2 Interpretation 102
4.5.3 Body Fluids 102
4.5.4 Toxicology 103
4.5.5 Fibres 104
4.6 Nuclear Magnetic Resonance Spectroscopy 104
4.6.1 Methods 104
4.6.2 Interpretation 105
4.6.3 Drugs 107
4.6.4 Explosives 108
4.7 Summary 109
References 109

5 Elemental Analysis 113

5.1 Introduction 113
5.2 Atomic Spectrometry 114
5.2.1 Methods 114
5.2.2 Interpretation 115
5.2.3 Glass 115
5.2.4 Gunshot Residue 116
5.2.5 Toxicology 116
5.3 Inductively Coupled Plasma–Mass Spectrometry 117
5.3.1 Methods 117
5.3.2 Interpretation 118
5.3.3 Glass 118
5.3.4 Paint 118
5.3.5 Gunshot Residue 119
5.4 X-Ray Fluorescence Spectroscopy 119
5.4.1 Methods 120
5.4.2 Interpretation 120
5.4.3 Glass 121
5.4.4 Gunshot Residue 122
5.4.5 Paint 122
5.5 Particle-Induced X-Ray Emission Spectroscopy 123
5.5.1 Methods 124
5.5.2 Interpretation 124
5.5.3 Glass 124

5.6 Neutron Activation Analysis 125
5.7 Summary 125
References 126

6 Mass Spectrometry 129

6.1 Introduction 129
6.2 Molecular Mass Spectrometry 129
6.2.1 Methods 130
6.2.2 Interpretation 132
6.2.3 Drugs 132
6.2.4 Explosives 134
6.3 Isotope Ratio Mass Spectrometry 134
6.3.1 Methods 135
6.3.2 Interpretation 136
6.3.3 Drugs 136
6.3.4 Explosives 136
6.4 Ion Mobility Spectrometry 137
6.4.1 Methods 137
6.4.2 Interpretation 137
6.4.3 Explosives 138
6.4.4 Drugs 138
6.5 Summary 140
References 140

7 Separation Techniques 143

7.1 Introduction 144
7.2 Paper Chromatography 144
7.2.1 Methods 144
7.2.2 Interpretation 144
7.2.3 Documents 145
7.3 Thin Layer Chromatography 145
7.3.1 Methods 146
7.3.2 Interpretation 146
7.3.3 Drugs 146
7.3.4 Documents 147
7.3.5 Fibres 148
7.3.6 Explosives 148
7.4 Gas Chromatography 149
7.4.1 Methods 149
7.4.2 Interpretation 150
7.4.3 Drugs 150
7.4.4 Toxicology 152

7.4.5 Arson Residues 154
7.4.6 Explosives 155
7.5 Liquid Chromatography 155
7.5.1 Methods 155
7.5.2 Interpretation 156
7.5.3 Drugs and Toxicology 156
7.5.4 Fibres 158
7.6 Ion Chromatography 159
7.6.1 Methods 159
7.6.2 Interpretation 159
7.6.3 Explosives 159
7.7 Capillary Electrophoresis 161
7.7.1 Methods 161
7.7.2 Interpretation 162
7.7.3 Drugs and Toxicology 162
7.7.4 Explosives and Gunshot Residues 163
7.8 Summary 163
References 164

8 Thermal Analysis 167

8.1 Introduction 167
8.2 Pyrolysis Techniques 168
8.2.1 Methods 168
8.2.2 Interpretation 168
8.2.3 Paint 169
8.2.4 Fibres 170
8.2.5 Polymers 170
8.2.6 Documents 171
8.3 Differential Scanning Calorimetry and Differential Thermal Analysis 171
8.3.1 Methods 171
8.3.2 Interpretation 171
8.3.3 Polymers 173
8.3.4 Fibres 173
8.4 Thermogravimetric Analysis 174
8.4.1 Methods 174
8.4.2 Interpretation 176
8.4.3 Polymers 177
8.4.4 Explosives and Arson Residues 177
8.5 Summary 178
References 178

Responses to Self-Assessment Questions **181**

Bibliography **195**

Glossary of Terms **197**

SI Units and Physical Constants **203**

Periodic Table **207**

Index **209**