Contents

Preface to the Third Edition xi
Preface to the Second Edition xiii
Preface to the First Edition xv
Acknowledgments xvii

PART I Surfaces and Three-Manifolds 1

1. Flatland 3
2. Gluing 13
3. Vocabulary 23
4. Orientability 41
5. Classification of Surfaces 59
6. Products 73
7. Flat Manifolds 87
8. Orientability vs. Two-Sidedness 115

PART II Geometries on Surfaces 123

9. The Sphere 125
10. The Hyperbolic Plane 135
11. Geometries on Surfaces 149
12. The Gauss-Bonnet Formula and the Euler Number 157

PART III Geometries on Three-Manifolds 179

13. Four-Dimensional Space 181
14. The Hypersphere 193
15. Hyperbolic Space 207
16. Geometries on Three-Manifolds I 215
17. Bundles 229
18. Geometries on Three-Manifolds II 241

PART IV The Universe 257

19. The Universe 259
20. The History of Space 279

Appendix A Answers 285
Appendix B Bibliography 319
Appendix C Conway's ZIP Proof 325
Index 339