

Contents

Preface	vii
To the Reader	xiii
1. The Basics	1
1.1 Measurement	1
1.2 Polygons	13
2. Grids	20
2.1. Billiards	20
2.2. Celtic Knots	30
3. Constructions	40
3.1. Ruler and Compass Constructions	40
3.2. The Pentagon and the Golden Ratio	51
3.3. Theoretical Origami	61
3.4. Knots and Stars	72
3.5. Linkages	78
4. Tessellations	85
4.1. Regular and Semiregular Tilings	85
4.2. Irregular Tilings	94
4.3. Penrose Tilings	115
5. Two-Dimensional Symmetry	127
5.1. Kaleidoscopes	127
5.2. Rosette Groups: Point Symmetry	138
5.3. Frieze Patterns: Line Symmetry	147
5.4. Wallpaper Patterns: Plane Symmetry	156
5.5. Islamic Lattice Patterns	171
6. Other Dimensions, Other Worlds	180
6.1. Flatlands	180
6.2. The Fourth Dimension	194

7. Polyhedra	208
7.1. Pyramids, Prisms, and Antiprisms	208
7.2. The Platonic Solids	216
7.3. The Archimedean Solids	224
7.4. Polyhedral Transformations	230
7.5. Models of Polyhedra	235
7.6. Infinite Polyhedra	253
8. Three-Dimensional Symmetry	263
8.1. Symmetries of Polyhedra	263
8.2. Three-Dimensional Kaleidoscopes	270
9. Spiral Growth	279
9.1. Spirals and Helices	279
9.2. Fibonacci Numbers and Phyllotaxis	290
10. Drawing Three Dimensions in Two	300
10.1. Perspective	300
10.2. Optical Illusions	315
11. Shape	329
11.1. Noneuclidean Geometry	329
11.2. Map Projections	336
11.3. Curvature of Curves	349
11.4. Curvature of Surfaces	359
11.5. Soap Bubbles	372
12. Graph Theory	383
12.1. Graphs	383
12.2. Trees	393
12.3. Mazes	401
13. Topology	411
13.1. Dimension	411
13.2. Surfaces	421
13.3. More About Surfaces	431
13.4. Map Coloring Problems	439
Hints and Solutions to Selected Problems	449
Bibliography	481
Index	489
Permissions	493