

Contents

Introduction	vii
1. The Basics	1
1.1. Measurement	2
1.2. Polygons	5
2. Grids	8
2.1. Billiards	9
2.2. Celtic Knots	16
3. Constructions	21
3.1. Ruler and Compass Constructions	23
3.2. The Pentagon and the Golden Ratio	28
3.3. Theoretical Origami	31
3.4. Knots and Stars	37
3.5. Linkages	42
4. Tessellations	46
4.1. Regular and Semiregular Tilings	47
4.2. Irregular Tilings	54
4.3. Penrose Tilings	61
5. Two-Dimensional Symmetry	67
5.1. Kaleidoscopes	69
5.2. Rosette Groups: Point Symmetry	74
5.3. Frieze Patterns: Line Symmetry	79
5.4. Wallpaper Patterns: Plane Symmetry	82
5.5. Islamic Lattice Patterns	92
6. Other Dimensions, Other Worlds	96
6.1. Flatlands	97
6.2. The Fourth Dimension	101

7. Polyhedra	104
7.1. Pyramids, Prisms, and Antiprisms	106
7.2. The Platonic Solids	111
7.3. The Archimedean Solids	115
7.4. Polyhedral Transformations	122
7.5. Models of Polyhedra	125
7.6. Infinite Polyhedra	126
8. Three-Dimensional Symmetry	132
8.1. Symmetries of Polyhedra	133
8.2. Three-Dimensional Kaleidoscopes	137
9. Spiral Growth	142
9.1. Spirals and Helices	143
9.2. Fibonacci Numbers and Phyllotaxis	148
10. Drawing Three Dimensions in Two	152
10.1. Perspective	153
10.2. Optical Illusions	159
11. Shape	165
11.1. Noneuclidean Geometry	167
11.2. Map Projections	171
11.3. Curvature of Curves	180
11.4. Curvature of Surfaces	186
11.5. Soap Bubbles	190
12. Graph Theory	196
12.1. Graphs	197
12.2. Trees	203
12.3. Mazes	208
13. Topology	218
13.1. Dimension	219
13.2. Surfaces	222
13.3. More About Surfaces	225
13.4. Map Coloring Problems	230
Appendix: Templates	235