

Contents

Preface	xi
1 How many sweets in the jar?	1
2 Loose change and tight packing	5
2.1 A handful of coins	5
2.2 When equal shares are best	6
2.3 Regular and semi-regular packings	11
2.4 Disordered, quasi-ordered and fractal packings	13
2.5 The Voronoi construction	16
3 Hard problems with hard spheres	20
3.1 The greengrocer's dilemma	20
3.2 Balls in bags	20
3.3 A new way of looking	22
3.4 How many balls in the bag?	24
3.5 Osborne Reynolds: a footprint on the sand	24
3.6 Ordered loose packings	27
3.7 Ordered close packing	27
3.8 The Kepler Conjecture	29
3.9 Marvellous clarity: the life of Kepler	32
3.10 Progress by leaps and bounds?	34
4 Proof positive?	35
4.1 News from the Western Front	35
4.2 The programme of Thomas Hales	37
4.3 At last?	39
4.4 Who cares?	42
4.5 The problem of proof	43
4.6 The power of thought	44

5 Peas and pips	45
5.1 Vegetable staticks	45
5.2 Stephen Hales	47
5.3 Pomegranate pips	48
5.4 The improbable seed	48
5.5 Biological cells, lead shot and soap bubbles	50
6 Enthusiastic admiration: the honeycomb	54
6.1 The honeycomb problem	54
6.2 What the bees do not know	56
7 Toils and troubles with bubbles	59
7.1 Playing with bubbles	59
7.2 A blind man in the kingdom of the sighted	60
7.3 Proving Plateau	63
7.4 Foam and ether	65
7.5 The Kelvin cell	68
7.6 The twinkling of an eye	70
7.7 Simulated soap	71
7.8 A discovery in Dublin	72
8 The architecture of the world of atoms	75
8.1 Molecular tactics	75
8.2 Atoms and molecules: begging the question	77
8.3 Atoms as points	78
8.4 Playing hardball	80
8.5 Modern crystallography	82
8.6 'Crystalline packings	83
8.7 Tetrahedral packing	85
8.8 Quasicrystals	87
8.9 Amorphous solids	89
8.10 Crystal nonsense	90
9 Apollonius and concrete	91
9.1 Mixing concrete	91
9.2 Apollonian packing	93
9.3 Packing fraction and fractal dimension	94
9.4 Packing fraction in granular aggregate	95
10 The Giant's Causeway	97
10.1 Worth seeing?	97
10.2 Idealization oversteps again	98
10.3 The first official report	99
10.4 Mallett's model	101
10.5 A modern view	102
10.6 Lost city?	102

11 Soccer balls, golf balls and buckyballs	103
11.1 Soccer balls	103
11.2 Golf balls	103
11.3 Buckyballs	105
11.4 Buckminster Fuller	107
11.5 The Thomson problem	107
11.6 The Tammes problem	108
11.7 Helical packings	110
12 Packings and kisses in high dimensions	113
12.1 Packing in many dimensions	113
12.2 A kissing competition	116
12.3 More kisses	117
13 Odds and ends	119
13.1 Parking cars	119
13.2 Stuffing sausages	120
13.3 Filling boxes	121
13.4 Goldberg variations	122
13.5 Packing pentagons	123
13.6 Dodecahedral packing and curved spaces	124
13.7 The Malfatti problem	125
13.8 Microspheres and opals	126
13.9 Order from shaking	127
13.10 Segregation	129
13.11 Turning down the heat: simulated annealing	130
14 Conclusion	133
Index	134