

Contents

Page numbers in *italics* refer to the commentary.

Preface xi

Introduction xii

1. **Three in a line** (a geometric investigation) 1 *133*
2. **Pawns on a chessboard** (an extension of Activity 1) 2 *134*
3. **Avoid three** (a geometric game for two players) 2 *134*
4. **Curves of pursuit** (a geometric construction) 3 *134*
5. **The misguided missiles** (an extension of Activity 4) 4 *134*
6. **Pattern** (a geometric pattern based on Activity 5) 5 *134*
7. **Two halves make a whole** (a geometric puzzle) 5 *135*
8. **Make your own dice** (a three-dimensional puzzle) 6 *135*
9. **Matchstick triangles** (a matchstick puzzle) 6 *135*
10. **The farmer's sheep-pens** (a geometric puzzle) 6 *136*
11. **Map folding** (a paper folding puzzle) 7 *136*
12. **A tricky river crossing** (a spatial puzzle) 7 *136*
13. **Stretching a circle** (a geometric construction) 8 *136*
14. **The ellipse** (an environmental investigation) 9 *136*
15. **Paper-folding an ellipse** (a geometric constructions) 10 *136*
16. **An ellipse using string and drawing pins** (a practical geometric construction) 11 *136*
17. **The sliding ladder** (a practical geometric construction and investigation) 11 *136*
18. **The growing network** (a spatial game for two players) 13 *137*
19. **Cubism** (a three-dimensional puzzle) 14 *137*
20. **Matchstick squares** (a matchstick puzzle) 14 *137*
21. **The square, cross and circle** (a three-dimensional puzzle) 15 *138*
22. **The baffled engine driver** (a railway shunting puzzle) 15 *138*
23. **The ingenious milkman** (a measuring puzzle) 15 *138*
24. **The army's predicament** (a river-crossing puzzle) 16 *138*
25. **Curves of constant breadth** (a geometric investigation) 16 *139*
26. **The Möbius band** (a practical geometric activity) 18 *139*

27. **Inside or outside** (a spatial investigation) 20 139
28. **Rolling along** (a geometric investigation) 21 140
29. **Which way is the wheel moving?** (a geometric investigation) 22 140
30. **Gear trains** (analysing the mathematics of gear wheels) 22 141
31. **Hex** (a spatial game for two players) 24
32. **The knights' dance** (a spatial puzzle) 26 142
33. **The railway sidings** (an intriguing shunting puzzle) 26 143
34. **The multi-coloured cube** (a tricky three-dimensional puzzle) 27 143
35. **The jealous husbands** (another boat puzzle) 27 144
36. **The extension lead** (a shortest route puzzle) 27 145
37. **The economical gardener** (a geometrical puzzle) 28 146
38. **Perimeter and area** (a pinboard investigation) 28 146
39. **Tessellations** (patterns on a pinboard) 28 147
40. **Tessellations and art** (a creative geometrical activity) 29 147
41. **Shapes with the same area** (another pinboard investigation) 29 148
42. **Area on a pinboard** (best done after activity 41) 30 149
43. **Routes on a pinboard** (an interesting geometrical investigation) 30 149
44. **Zigzag** (a dotty paper game for two) 31
45. **How many triangles can you make?** (a pinboard investigation) 31 150
46. **How many triangles can you see?** (a geometric puzzle) 31 151
47. **The unfriendly power-boats** (an intriguing puzzle) 32 152
48. **Traversibility** (two topological puzzles) 32 152
49. **The knight-guards** (a chessboard puzzle) 33 153
50. **Reversing the trains** (another baffling shunting puzzle) 33 154
51. **The parallelogram linkage** (a practical geometrical investigation) 34 155
52. **Rocking horses** (a model-making activity) 36 155
53. **Turning circles** (a geometrical model to represent a car's steering mechanism) 37 155
54. **Straight-line motion – well almost!** (geometrical models to represent mechanisms of historical significance) 38 155
55. **About turn** (linkages to stimulate a rotation of 180°) 39 155
56. **Knight lines** (a new game for two) 40
57. **Quadruplets** (a dissection puzzle) 42 155

58. **Complete the square** (a geometric jigsaw puzzle) 42 156
59. **Roll a penny** (a rotation puzzle) 42 156
60. **The hunter** (a geographical puzzle) 43 156
61. **Four points in a plane** (a geometrical puzzle) 43 156
62. **The letter dice** (a three-dimensional puzzle) 43 157
63. **Make yourself a hexaflexagon** (a fascinating topological model to make) 44 157
64. **Perigal's dissection** (a demonstration of pythagora' theorem) 46 157
65. **Make a tetrahedron to baffle your friends** (a three-dimensional polyhedron puzzle) 47 157
66. **The cone which rolls uphill** (another perplexing model to make) 48
67. **Ruler and compass constructions** 49 157
68. **Circumscribing, inscribed and escribed circles** (further ruler and compass constructions) 50 157
69. **Submarines, cruisers and helicopters** (a three-dimensional game for two) 52 158
70. **The queen's defence** (a chessboard puzzle) 54 158
71. **Seeing is believing!** (a geometric paradox) 54 160
72. **Inspecting the roads** (a geometric puzzle) 55 160
73. **Dominoes on a chessboard** (a tessellation puzzle) 55 160
74. **Identical twins** (a dissection puzzle) 55 160
75. **The four-colour theorem** (a topological puzzle) 56 161
76. **The pentominoes** (an investigation into shapes made with five squares) 56 161
77. **The hexominoes** (an extension of the ideas in Activity 76) 57 162
78. **Building up cubes** (a three-dimensional investigation) 59 163
79. **Half a cube** (a three-dimensional challenge) 60 165
80. **Make yourself a polyhedron construction kit** (a way of creating a large variety of polyhedra) 61 165
81. **The dodecahedron and stellated dodecahedron** (how to construct two polyhedra) 63 165
82. **An isometry game** (a game to make for two to four players) 66 166
83. **Sawing up a cube** (a three-dimensional dissection puzzle) 69 166
84. **The improbable hole** (a three-dimensional paradox) 69 166
85. **Equilateral triangle to square** (a fascinating geometric dissection) 69 166
86. **Squaring the urn** (another geometric dissection) 70 167

87. **The baffled housewife** (a timetable puzzle) 70 167
88. **Invert the triangle** (a moving penny puzzle) 70 167
89. **Knight's tours** (a chessboard puzzle/investigation)
71 168
90. **Distance has a new meaning** (a geometrical
investigation) 74 169
91. **Avoid that snooker** (a practical application of reflection)
75 170
92. **Euler's relation** (a topological investigation) 77 171
93. **Curves from intersecting circles** (some unusual
geometrical constructions) 80 171
94. **Make yourself a ruled surface** (a three-dimensional
model to make) 82 172
95. **Squares** (a geometric game for two players) 83 172
96. **The hungry bookworm** (a geometric puzzle) 83 172
97. **Place the motorway junction** (a geometric puzzle)
84 172
98. **How fast can you cycle?** (a distance-time-speed puzzle)
84 173
99. **The bob-sleigh run** (a spatial puzzle) 85 173
100. **Know your vowels!** (a dissection puzzle) 85 174
101. **Space filling** (a three-dimensional puzzle) 85 174
102. **Diagonals of a rectangle** (a space/number investigation)
86 174
103. **Straight lines divide a plane** (another space/number
investigation) 86 174
104. **Number sequences - differencing** (a way of investigating
number patterns) 87 175
105. **Number patterns from dotty patterns** (generating
number sequences) 88 176
106. **Squares on a pinboard** (a number and spatial
investigation) 89 177
107. **From polygons to frieze patterns** (a geometrical
investigation which links with an unusual family of
number patterns) 90 177
108. **Games on a pegboard for one to play** 92 179
109. **Two of a kind** (a dissection puzzle) 94 179
110. **Colouring a cube** (a topological puzzle) 94 179
111. **Cutting up a circle** (a space/number puzzle) 95 180
112. **Square relations** (a number puzzle - calculator useful)
95 180
113. **The numerate gardener** (a number puzzle - calculator
useful) 95 181
114. **Magic triangles** (an arithmetic puzzle) 96 181
115. **Number patterns** (mainly multiplication - calculator
useful) 96 182
116. **Surprising subtractions** (subtraction of four figure
numbers - calculator a help but not essential) 97 183

117. **How large a number can you get?** (sums and products of two, three and four figure numbers – use a calculator) 97 183
118. **Unit fractions** (addition and subtraction of simple fractions) 98 184
119. **Four 4s** (an arithmetic activity to exploit ingenuity) 98 184
120. **Calculator words** (an imaginative use of a calculator) 99 185
121. **Some calculator challenges** (find the missing numbers with the help of a calculator) 100 185
122. **A calculator crossword** (calculator essential – an amusing interlude) 101 186
123. **A mining bonanza** (a calculator challenge for one or more) 102 186
124. **Hundreds, tens and units** (simple arithmetic – spot the patterns) 103 187
125. **Magic circles** (an arithmetic puzzle involving addition) 103 187
126. **Number wheels** (another arithmetic addition puzzle) 104 188
127. **Make a century** (an arithmetic challenge) 104 189
128. **Division patterns** (using a calculator to investigate patterns of recurring number sequences) 104 189
129. **Prime numbers** (an investigation into some known facts about prime numbers) 106 190
130. **Generating prime numbers** (a look at ways which have been attempted to generate the primes) 108 192
131. **Some named numbers** (an investigation of some special numbers) 109 192
132. **Further number patterns** (an arithmetic activity – a calculator would be helpful) 110 193
133. **Pythagorean triads** (a number activity related to right-angled triangles) 110 194
134. **Guess the rule** (a game for two or more players involving number relations) 111 194
135. **Intriguing multiplications** (a multiplication puzzle requiring intelligent use of trial and error with a calculator) 112 194
136. **Equate the diagonals** (a number puzzle involving pythagoras' theorem) 112 195
137. **Magic stars** (an arithmetic puzzle involving addition) 113 195
138. **Safety first** (two addition puzzles) 113 196
139. **The gambler's secret strategy** (a probability puzzle) 114 196
140. **The transportation problem** (a practical arithmetical activity/puzzle) 114 196

141. **'Mind reading' number cards** (a number trick to make and use) 115 197
 142. **3 × 3 magic squares** (an arithmetic investigation involving addition) 116 197
 143. **4 × 4 and higher order magic squares** (an extension of Activity 142) 118 198
 144. **Multigrades** (some intriguing number relations) 120 199
 145. **Pascal's triangle** (investigation into this frequently occurring number pattern) 122 199
 146. **Generating Fibonacci sequences** (investigation of this interesting number sequence) 125 200
 147. **Fibonacci sequences and the golden section ratio** (a look at some fascinating number/geometry relations) 127 200
 148. **A weighing problem** (an arithmetic puzzle) 128 201
 149. **Similar rectangles** (a space/number problem) 128 201
 150. **A magic cube** (an addition puzzle) 129 202
 151. **A question of balance** (a question of organisation) 129 202
 152. **Further calculator challenges** (find out new techniques with your calculator) 129 202
 153. **The only magic hexagon** (an addition puzzle) 130 203
 154. **Nim** (a number game for two players) 130 204
- Further resources 205