

## A guide to use GeoGebra when teaching AS and A level Further Mathematics

Below you can find links to GeoGebra files designed to help you teach the content of AS and A level Further Mathematics qualifications with the aid of GeoGebra.

These can be used for teaching, or as students' aided or independent learning materials with Pearson Textbooks.

### Core Pure Mathematics

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[Core Pure Year 2](#)

### Options

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## AS/Year 1 Further Mathematics – Core Pure

### Argand diagrams (Chapter 2)

Explore adding and subtracting complex numbers on an Argand diagram. (Page 19)

- [GeoGebra interactive](#)

Explore multiplying and dividing complex numbers on an Argand diagram. (Page 25)

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Explore the locus of  $z$ , when  $|z - z_1| = r$  (Page 28)

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Explore the locus of  $z$ , when  $|z - z_1| = |z - z_2|$  (Page 29)

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Explore the locus of  $z$ , when  $\arg(z - z_1) = \theta$  (Page 32)

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Explore shaded region on an Argand diagram. (page 37)

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### Volumes of revolution (Chapter 5)

- Page 76: Explore volumes of revolution around the x- and y-axes using GeoGebra.

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## AS/Year 1 Further Mathematics – Core Pure (Cont'd)

### Linear transformations (Chapter 7)

Explore rotations of the unit square. (Page 134)

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Explore enlargements and stretches of triangle T. (Page 137)

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Explore rotations about the coordinate axes. (Page 145)

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### Vectors (Chapter 9)

Explore the vector equation of a line. (Page 168)

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Explore the vector and Cartesian equations of a plane. (Page 176)

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Use GeoGebra to consider the scalar product as the component of one vector in the direction of another. (Page 179)

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Explore the angle between a line and a plane. (Page 186)

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Visualise the angle between two planes. (Page 187)

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Explore the perpendicular distance between two lines. (Page 194)

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Explore reflections in a plane using GeoGebra. (Page 198)

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## Year 2/ A level Further Mathematics – Core Pure

### Complex numbers (Chapter 1)

Explore  $n$ th roots of complex numbers in an Argand diagram. (Page 25)

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### Series (Chapter 2)

Explore graphs of the successive Maclaurin polynomials. (Page 42)

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## Year 2/ A level Further Mathematics – Core Pure (Cont'd)

### Methods in calculus (Chapter 3)

Explore the integral. (Page 54)

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### Volumes of revolution (Chapter 4)

Explore volumes of revolution around the x-axis. (Page 78)

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Explore volumes of revolution around the y-axis. (Page 81)

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### Polar coordinates (Chapter 5)

Explore curves given in polar form using GeoGebra. (Page 106)

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Explore the area enclosed by a loop of the polar curve with the form  $r = a \sin \theta$ . (Page 110)

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### Hyperbolic functions (Chapter 6)

Explore graphs of hyperbolic functions. (Page 122)

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### Methods in differential equations (Chapter 7)

Explore families of solution curves. (Page 148)

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### Modelling with differential equations (Chapter 8)

Explore simple harmonic motion. (Page 175)

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Explore damped harmonic motion. (Page 181)

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Explore forced harmonic motion. (Page 183)

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## A level Further Mathematics – Further Pure 1

### Vectors (Chapter 1)

Explore the cross product of two vectors. (Page 2)

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Explore the area of a parallelogram using vector notation. (Page 8)

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Explore the scalar triple product. (Page 11)

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Explore the vector equation of a line, written using a cross product. (Page 16)

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### Conic sections 1 (Chapter 2)

Explore the focus-directrix properties of a parabola. (Page 35)

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Explore the locus of M. (Page 56 Question 7)

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### Conic sections 2 (Chapter 3)

Explore conic sections. (Page 63)

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Explore the foci and directrices of an ellipse. (Page 69)

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Explore the foci and directrices of a hyperbola. (Page 72)

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Explore the locus of the midpoint of AB. (Page 84)

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### Inequalities (Chapter 4)

Explore the solution to the inequality. (Page 97)

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Explore the solution to the inequality. (Page 101)

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## A level Further Mathematics – Further Pure 1 (Cont'd)

### Taylor series (Chapter 6)

Explore the Taylor series expansion of  $f(x) = \tan x$  (Page 133)

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### Methods in calculus (Chapter 7)

Explore the graph of the function  $t = e^{\ln t}$  (Page 154)

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### Numerical methods (Chapter 8)

Explore tangent fields. (Page 162)

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Page 174: Explore the use of Simpson's rule to estimate the integral. (Page 174)

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## A level Further Mathematics – Further Pure 2

### Number theory (Chapter 1)

Implement the Euclidean algorithm. (Page 6)

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Carry out divisibility tests. (Page 17)

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Explore permutations. (Page 31)

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Explore combinations. (Page 33)

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### Groups (Chapter 2)

Explore groups of symmetries. (Page 57)

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Explore generators. (Page 69)

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## A level Further Mathematics – Further Pure 2 (Cont'd)

### Complex numbers (Chapter 3)

Explore the locus of  $z$  when  $|z - a| = k|z - b|$  (Page 88)

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Explore the locus of  $z$  when  $\arg((z - a)/(z - b)) = \theta$  (Page 91)

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Explore this region. (Page 98)

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Explore these transformations. (Page 101)

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### Recurrence relations Chapter 4)

Play the Tower of Hanoi. (Page 130)

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### Matrix algebra (Chapter 5)

Explore eigenvalues and eigenvectors. (Page 155)

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### Integration techniques (Chapter 6)

Explore the use of integration to find the arc length between two points. (Page 199)

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Explore the use of integration to find the length of an arc on a curve with a polar equation.  
(Page 201)

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Explore the use of integration to find the area of a surface of revolution. (Page 208)

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## A level Further Mathematics – Further Statistics 1

### Discrete random variables (Chapter 1)

Explore probability distributions of a discrete random variable and compare the theoretical distribution with observed results generated from that discrete random variable. (Page 5)

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## A level Further Mathematics – Further Statistics 1 (Cont'd)

### Poisson distributions (Chapter 2)

Explore the Poisson distribution. (Page 21)

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### Geometric and negative binomial distributions (Chapter 3)

Explore the geometric distribution. (Page 44)

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Explore the cumulative geometric distribution. (Page 45)

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Explore the negative binominal distribution. (Page 50)

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### Hypothesis testing (Chapter 4)

Explore critical regions for a Poisson distribution. (Page 63)

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Explore critical regions for a geometric distribution. (Page 70)

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### Chi-squared tests (Chapter 6)

Explore the chi-squared distribution to determine critical values for goodness of fit. (Page 98)

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### Quality of tests (Chapter 8)

Explore probabilities of Type I and Type II errors in a normal distribution. (Page 154)

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## A level Further Mathematics – Further Statistics 2

### Linear regression (Chapter 1)

Explore the calculation of a least squares regression line. (Page 3)

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Explore residuals of data points and reasonableness of fit. (Page 11)

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## A level Further Mathematics – Further Statistics 2 (Cont'd)

### Correlation (Chapter 2)

Explore linear correlation between two variables, measured by the PMCC. (Page 22)

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Explore Spearman's rank correlation coefficient. (Page 27)

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### Continuous distributions (Chapter 3)

Explore probability density functions. (Page 46)

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Explore cumulative distribution functions. (Page 51)

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### Estimation, confidence intervals and tests using a normal distribution (Chapter 5)

Explore biased and unbiased estimators. (Page 114)

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### Further hypothesis tests (Chapter 6)

Explore the F-distribution using GeoGebra and use it to determine critical values of the sample variances. (Page 151)

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### Confidence intervals and tests using the t-distribution (Chapter 7)

Explore the t-distribution using GeoGebra and use it to determine critical values of the sample variances. (Page 165)

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## A level Further Mathematics – Further Mechanics 1

### Momentum and impulse (Chapter 1)

Explore particle collisions. (Page 4)

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Explore collisions with two moving particles. (Page 5)

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Explore particle collisions with known impulse. (Page 7)

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Explore particle collisions in two dimensions. (Page 10)

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### Elastic strings and springs (Chapter 3)

Explore Hooke's law in equilibrium problems involving two elastic springs. (Page 41)

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Explore Hooke's law in equilibrium problems involving one elastic spring. (Page 42)

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Explore Hooke's law in dynamics problems. (Page 47)

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### Elastic collisions in one dimension (Chapter 4)

Explore direct impact. (Page 72)

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Explore direct impact with a known impulse. (Page 73)

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Explore the direct collision of a falling particle with a smooth plane. (Page 77)

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Explore the loss of kinetic energy in a collision. (Page 80)

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Explore successive collisions. (Page 85)

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Explore successive impacts of a falling particle. (Page 88)

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## A level Further Mathematics – Further Mechanics 1 (Cont'd)

### Elastic collisions in two dimensions (Chapter 5)

Explore oblique impact with a fixed surface. (Page 97)

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Explore successive oblique impacts with a fixed surface. (Page 105)

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Explore oblique impacts of smooth spheres. (Page 111)

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## A level Further Mathematics – Further Mechanics 2

### Circular motion (Chapter 1)

Explore circular motion of a particle attached to a light inextensible string. (Page 6)

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Explore circular motion in three dimensions. (Page 11)

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Explore vertical circular motion. (Page 20)

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Explore motion of a particle not constrained on a circular path. (Page 26)

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### Centres of mass of plane figures (Chapter 2)

Explore the centre of mass of systems of particles. (Page 37)

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Explore the centre of mass of particles arranged in a plane. (Page 39)

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Explore centres of mass of standard uniform plane laminas. (Page 45)

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Explore centres of mass of a framework. (Page 55)

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## A level Further Mathematics – Further Mechanics 2 (Cont'd)

### Further centres of mass (Chapter 3)

Explore the centre of mass of a solid of revolution. (Page 90)

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Explore toppling and sliding. (Page 110)

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### Kinematics (Chapter 4)

Explore terminal or limiting velocity. (Page 162)

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### Dynamics (Chapter 5)

Explore simple harmonic motion. (Page 184)

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Explore calculations for simple harmonic motion with a reference circle. (Page 191)

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Explore the simple harmonic motion of a vertical spring. (Page 201)

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## A level Further Mathematics – Decision 1

### Algorithms (Chapter 1)

See the operation of the first-fit algorithm using GeoGebra. (Page 17)

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See the operation of the first-fit decreasing algorithm using GeoGebra. (Page 18)

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## A level Further Mathematics – Decision 1 (Cont'd)

### Algorithms on graphs (Chapter 3)

Example 1: Explore Kruskal's algorithm using GeoGebra. (Page 53)

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Example 2: Explore Kruskal's algorithm using GeoGebra. (Page 54)

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Explore Prim's algorithm using GeoGebra. (Page 57)

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Explore Dijkstra's algorithm using GeoGebra. (Page 66)

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Explore Floyd's algorithm using GeoGebra. (Page 76)

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### Linear programming (Chapter 7)

Explore graphical solutions to linear programming problems. (Page 147)

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Explore how the optimal solution can be found using the objective line method. (Page 150)

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Explore how the optimal solution can be found using the objective line method. (Page 153)

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Explore how the optimal solution can be found using the objective line method. (Page 154)

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Explore how the optimal solution can be found using the objective line method. (Page 155)

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Explore how the optimal solution can be found using vertex testing. (Page 157)

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Explore how the optimal solution can be found using vertex testing. (Page 158)

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Explore how the optimal solution can be found using the objective line method. (Page 163)

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## A level Further Mathematics – Decision 1 (Cont'd)

### Critical path analysis (Chapter 8)

Explore event times in activity networks. (Page 230)

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Explore critical paths. (Page 233)

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## A level Further Mathematics – Decision 2

### Transportation problems (Chapter 1)

Explore how the north-west corner method can be used to find an initial solution. (Page 4)

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Explore how to calculate shadow costs. (Page 13)

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Explore how to calculate improvement indices. (Page 16)

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Explore how to obtain an improved solution with the stepping stone method. (Page 16)

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### Flows in networks 1 (Chapter 3)

Explore cuts and their capacities in this network. (Page 81)

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Find feasible flows on this network. (Page 89)

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### Flows in networks 2 (Chapter 4)

Explore feasible flows through a directed network with lower and upper capacities. (Page 113)

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Explore cuts in a directed network with upper and lower capacities. (Page 116)

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### Game theory (Chapter 6)

Find stable solutions for zero-sum games. (Page 186)

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Explore the optimal solution to two-player zero-sum game with no stable solution. (Page 199)

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## A level Further Mathematics – Decision 2 (Cont'd)

### Recurrence relations (Chapter 7)

Play the Tower of Hanoi. (Page 224)

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### Decision analysis (Chapter 8)

Explore EMV. (Page 246)

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