# Pure Mathematics: Graphs

| **Specification** | **Ref.** | **Learning outcomes** | **Notes** | **Notation** | **Exclusions** |
| --- | --- | --- | --- | --- | --- |
| **PURE MATHEMATICS: GRAPHS (1)** |
| Graphs | MC1 | Understand and use graphs of functions. |  |  |  |
| Sketching curves | C2 | Understand how to find intersection points of a curve with coordinate axes. | Including relating this to the solution of an equation. |  |  |
| C3 | Understand and be able to use the method of completing the square to find the line of symmetry and turning point of the graph of a quadratic function and to sketch a quadratic curve (parabola). | The curve  has* a minimum at  for  or

a maximum at  for *a* < 0* a line of symmetry .
 |  |  |
| C4 | Be able to sketch and interpret the graphs of simple functions including polynomials. | Including cases of repeated roots for polynomials. |  |  |
| C5 | Be able to use stationary pointswhen curve sketching. | Including distinguishing between maximum and minimum turning points. |  |  |
| C6 | Be able to sketch and interpret the graphs of  and . | Including their vertical and horizontal asymptotes and recognising them as graphs of proportional relationships. |  |  |
| Transform-ations  | C7 | Be able to sketch curves of the forms  and , given the curve of  and describe the associated transformations. Be able to form the equation of a graph following a single transformation. | Including working with sketches of graphs where functions are not defined algebraically. | Map(s) onto.Translation, stretch, reflection |  |
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| **PURE MATHEMATICS: GRAPHS (2)** |
| Transform-ations | MC8 | Understand the effect of combined transformations on a graph and be able to form the equation of the new graph and to sketch it. Be able to recognise the transformations that have been applied to a graph from the graph or its equation. |  | Vector notation may be used for a translation.,   |  |
| Sketching curves | C9 | Be able to use stationary points of inflection when curve sketching. |  |  |  |

# Resources

| **Title** | **Organisation** | **Description** | **Ref** |
| --- | --- | --- | --- |
| [Roots of a Quadratic Equation: Discriminant](https://www.youtube.com/watch?v=awL6Znlemoo) | ExamSolutions | This excellent video resource demonstrates how to solve quadratic equations using the quadratic formula. It then demonstrates how to use the discriminant to determine the number and nature of the roots of the quadratic equation and then relates the results to a graph. |  C2 |
| [Solving Equations by Graphing](https://www.khanacademy.org/math/algebra2/advanced-functions#solving-equations-by-graphing) | Khan Academy | This challenging resource includes text and videos and covers interpreting equations graphically and solving equations graphically. |  C2 |
| [Points of Intersection on Graphs AS Maths](https://www.youtube.com/watch?v=tISoZtCcBIo) | Starfish Maths | This excellent video resource demonstrates how to find the points of intersection on graphs, including finding where lines, circles and curves cross.  |  C2 |
| [Quadratic Roots and Using Graphs](https://www.tes.com/teaching-resource/introducing-quadratic-roots-and-solving-quadratic-equations-graphically-11270005) | TES | This resource includes a worksheet and offers learners the opportunity to practice their understanding of interpreting algebraic solution of equations graphically. |  C2 |
| [Graphs of Polynomial Functions](https://www.youtube.com/watch?v=OcjD6vYD7ic) | Textbook Tactics | This excellent video resource introduces learners to sketching polynomials. |  C2 and C5 |
| [Examples on the Nature of Roots of a Quadratic Equation](https://www.youtube.com/watch?v=zepJRXw-3o4) | ExamSolutions | This excellent video resource demonstrates how to use the discriminant to determine the number and nature of the roots of the quadratic equation and then relates the results to a graph. |  C3 |
| [Graphs of Eight Bic Types of Function](http://mathonweb.com/help_ebook/html/functions_4.htm) | mathonweb | This simple resource covers the graphs of different types of functions. |  C4 |
| [Sketching Polynomials](https://math.usask.ca/emr/examples/grpo_eg4.html) | University of Saskatchewan | This short resource demonstrates how to sketch polynomials by using two examples. |  C4 |
| [Sketching Polynomial Graphs](https://www.youtube.com/watch?v=pvSzcBKJvu4) | MrBgottschalk | This excellent video resource demonstrates how to sketch polynomial functions. |  C4 |
| [Polynomial Functions and Their Graphs](http://www.tkiryl.com/Precalculus/Section_3.2-Polynomial%20Functions%20and%20Their%20Graphs/Polynomial%20Functions%20and%20Their%20Graphs.pdf) | University of Texas at Austin | This comprehensive resource introduces learners to sketching polynomial graphs. It includes examples with detailed solutions. |  C4 |
| [Sketching Curves Whodunnit?](http://www.ocr.org.uk/Images/181376-sketching-curves-whodunnit-lesson-element-teacher-instructions-and-task.pdf) | OCR | This enjoyable resource invites learners to use their knowledge of sketching quadratic graphs to solve a crime. It tries to address the misconceptions involved with quadratic graphs. |  C4 |
| [Can you find... cubic edition](https://undergroundmathematics.org/polynomials/can-you-find-cubic-edition) | Underground Maths | Investigation that encourages learners to use their knowledge of the general shape of cubic graphs and the different ways that the curve can be positions to meet specific coordinate criteria. |  C4 |
| [How not to solve a cubic...](https://undergroundmathematics.org/polynomials/how-not-to-solve-a-cubic) | Underground Maths | Investigation to find a cubic and a quadratic that intersect at   |  C4 |
| [Functions - Graphs](https://www.geogebra.org/m/VrkX32Uq) | Geogebra | Investigate the shape of different polynomial functions | C4 |
| [Stationary points](https://www.geogebra.org/m/WyxeGtWS) | Geogebra | Learners can investigate the position of stationary points for family of curves. Links to calculated values of   and  to introduce application of calculus.  | C5 |
| [Sketching a Graph](https://portal.uea.ac.uk/documents/6207125/8198428/bridging%2Balgebra%2Bcalculus%2Bsketching%2Ba%2Bgraph.pdf) | University of East Anglia | This resource explains the difference between plotting and sketching a curve. It also looks at sketching curves defined by simple equations including polynomials. |  C6 |
| [Graphs of Reciprocal Functions](http://www.onlinemathlearning.com/reciprocal-function.html) | OnlineMath Learning.com | This excellent resource demonstrates how to graph reciprocal functions and also how to get the equation of a reciprocal function when given its graph. It also includes a video resource demonstrating how to graph transformations of reciprocal functions. |  C6 |
| [Sketching Reciprocal Graphs of the form](https://www.youtube.com/watch?v=9fpGSyFZUGM)  | ExamSolutions | This excellent video resource demonstrates how to sketch reciprocal graphs. |  C6 |
| [Translating or not?](https://undergroundmathematics.org/combining-functions/translating-or-not) | Underground Maths | Investigation looking at family of curves for  and   | C6 |
| [Reciprocal function](https://www.geogebra.org/m/R4WRZsNs) | Geogebra | Use of sliders to investigate family of curves  including the vertical and horizontal asymptotes. | C6 |
| [Asymptotes –What are they?](https://www.youtube.com/watch?v=5Hl_WJXcR6M) | ExamSolutions | This excellent video resource introduces learners to asymptotes. |  C6 and C7 |
| [Graphs and Transformations](https://www.slideshare.net/timschmitz/higher-maths-122-graphs-and-transformations) | In SlideShare | This excellent resource includes five slides and introduces learners to graph transformations. |  C7 |
| [Graph Transformations](https://www.math.utah.edu/~wortman/1050-text-gt.pdf) | University of Utah | This comprehensive resource demonstrates the effects of simple transformations on graphs. It includes questions for learners to attempt. |  C7 |
| [Transformation of Functions](https://www.youtube.com/watch?v=IFT2uznB7fM) | mathtutodvd | This excellent short video resource demonstrates the effects of simple transformations on graphs. |  C7 |
| [Transformations of Functions 1](https://www.youtube.com/watch?v=yP_ZpQnZyU0) | MrAlnoldsMaths | This excellent video resource demonstrates the effects of simple transformations on graphs. It includes examples and solutions. |  C7 |
| [Graph Transformation](https://brilliant.org/wiki/graph-transformation/) | brilliant.org | This excellent resource demonstrates the different type of graph transformations and includes combination of transformations. It gives examples with detailed solutions. |  C7 and C8 |
| [Transformations](http://www.s-cool.co.uk/a-level/maths/functions/revise-it/transformations) | S-cool | This excellent resource demonstrates the effects of simple transformations on graphs. |  C8 |
| [Combining Transformations](https://online.math.uh.edu/Math1330-unpaid/ch1/s13/CombTransf/Combining_Transformations_Math1330_s13.pdf) | University of Utah | This challenging resource demonstrates the effect of a combination of transformations on graphs of functions. It includes examples with detailed solutions. |  C8 |
| [Transformations – Combination Example 1](https://www.youtube.com/watch?v=PvXPKiwjX6I) | Brian Veitch | This excellent short video resource demonstrates in a very simple way, the effect of a combination of transformations on a graph. |  C8 |
| [Transformatoin - Combination Example 2](https://www.youtube.com/watch?v=GcIO1Z01r8o) | Brian Veitch | This excellent short video resource demonstrates in a very simple way, the effect of a combination of transformations on a graph. |  C8 |
| [Graph Transformations](https://www.youtube.com/watch?v=0a-AjP4UdnY) | Hegartymaths | This excellent video resource demonstrates the effects of a combination of transformations on graphs. |  C8 |
| [Graphical Transformations of Functions](http://michelenaja.faculty.mjc.edu/transformations_of_graphs/Math_90_transformations_of_graphs_of_functions.pdf) | Modesto Junior College | This excellent resource demonstrates the effect of a combination of transformations on graphs of functions. It includes examples with solutions. |  C8 |