

# Further Maths – Preparation for Sixth Form

Congratulations on choosing to enter the wonderful world of Further Mathematics.




As well as understanding the fundamentals of the subject in more depth, you will be introduced to complex numbers, matrices, algorithms, hyperbolics, collisions and multi-dimensional space.

To make sure you are ready for this, you must have a strong understanding of algebra and geometry. You will gain this from thoroughly completing the work for 'Normal' Mathematics.

Rather than getting into the technicalities of some of these new ideas, we want you to understand the bigger picture behind the discipline.

Complete all of the 'Top 5' over the next five weeks.

Then there are a list of other suggestions. We are not expecting you to work your way through the list in order, and certainly wouldn't expect anyone to tackle all of them, but rather see what interests you and explore.

			Complete
Compulsory preparation work	 Mr Barker recommends...	<p>What is maths? And how can we talk about an infinite number of objects/numbers if infinity is not itself a number?</p> <p>In Mathematics and Further Mathematics you will consider limits, what happens as we get infinitely big or infinitely small? And beyond that what are we talking about when we use numbers or sets? Is maths a tool, a language, art, all of the above?</p> <p>This short podcast is a great way to start thinking about these concepts with a mildly comedic undertone <a href="https://www.bbc.co.uk/sounds/play/b03kpy5c">https://www.bbc.co.uk/sounds/play/b03kpy5c</a></p>	
	 Mr Hamilton recommends...	<p>Simon Singh's documentary on Fermat's Last Theorem was so widely acclaimed that, even though first aired in 1995, it has had a lasting impact on those who saw it (or so I'm told by the older members of our department).</p> <p>It is <i>the</i> classic mathematics documentary and can be viewed here: <a href="https://www.bbc.co.uk/iplayer/episode/b0074rxx/horizon-19951996-fermats-last-theorem">https://www.bbc.co.uk/iplayer/episode/b0074rxx/horizon-19951996-fermats-last-theorem</a></p>	
	 Mr Newton recommends...	<p>This video was shared with me by a student in Y12 who was researching fractals for an EPQ (Extended Project Qualification). EPQs are great, you get an opportunity to explore a subject you are interested in and also get a qualification that may support a university application or make your CV stand out.</p> <p>The video gives an interesting introduction into chaos and the Feigenbaum constant. It also touches on numerous interesting areas of mathematics such as fractals and complex numbers.  <a href="https://www.youtube.com/watch?v=ovJcsL7vyrk&amp;feature=youtu.be">https://www.youtube.com/watch?v=ovJcsL7vyrk&amp;feature=youtu.be</a></p> <p>If this gives you an appetite to explore more, here is an introduction to Fractals: <a href="https://www.youtube.com/watch?v=w_MNQBWQ5DI">https://www.youtube.com/watch?v=w_MNQBWQ5DI</a></p> <p>Here is an introduction to complex numbers, a big part of the Further Maths course): <a href="https://www.youtube.com/watch?v=hqr1DtXXHpY">https://www.youtube.com/watch?v=hqr1DtXXHpY</a></p> <p>And here is a bit more on the Mandelbrot set from Numberphile: <a href="https://www.youtube.com/watch?v=NGMRB4O922I">https://www.youtube.com/watch?v=NGMRB4O922I</a></p>	



Mrs Stott recommends...

The mathematician Prof John Horton Conway died earlier this month. As well as contributing significantly to the development of notation in various fields of mathematics, he was a recreational mathematician who learnt through games.

Listen to this podcast:

<https://www.bbc.co.uk/sounds/play/p08b9bcq>

“Follow your curiosity – no matter how trivial it might be it might lead you somewhere unexpected. There is value in being idle... The idle time allows you room to cogitate and ferment these ideas and unexpected things can emerge.”

1. Play sprouts with someone in your household

Starting with a few spots on a sheet of paper, players take turns to draw a line between two spots (or from a spot to itself) adding a new spot somewhere along the line. The line may be straight or curved, but must not touch or cross itself or any other line.

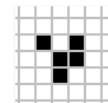
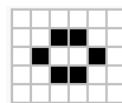
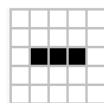
No spot may have more than three lines attached to it.

The player who makes the last move wins.

Can you work out a strategy for winning the game?

What are the maximum/minimum number of moves for n spots?

2. Using a chessboard, or squared paper, use the first three starting points to recreate Game of Life.



Every cell interacts with its eight neighbours - cells that are horizontally, vertically, or diagonally adjacent. At each step in time, the following transitions occur:

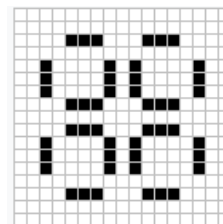
Any live cell with two or three live neighbours survives.

Any dead cell with three live neighbours becomes a live cell.

All other live cells die in the next generation. Similarly, all other dead cells stay dead.

What do you notice?

If you want to take it further, try this one:



Dr Young recommends...

Many of the writers of The Simpsons and Futurama have mathematics backgrounds. Watch this explanation of the Futurama Theorem developed for the episode ‘The Prisoner of Benda’.

<https://www.youtube.com/watch?v=J65GNFfl94c>

If you want to know more, you can read this paper on the result: <https://arxiv.org/pdf/1204.6086.pdf>

or this one generalising the result: <https://arxiv.org/pdf/1608.04809.pdf>

or see the book section for The Simpsons and their Mathematical Secrets.

Suggested preparation work	Talks	<p>TED Talks  <a href="https://www.ted.com/playlists/189/math_talks_to_blow_your_mind">https://www.ted.com/playlists/189/math_talks_to_blow_your_mind</a>            You must NEVER use the word 'math' but they are forgiven as this list includes a talk by Benoit Mandelbrot, the father of fractals, and Marcus du Sautoy talking about symmetry.</p> <p>Gresham College Lectures  <a href="https://www.gresham.ac.uk/lectures/?subject=mathematics">https://www.gresham.ac.uk/lectures/?subject=mathematics</a>            A collection of traditional lectures on areas of mathematics. I enjoyed 'The Art of Maths'</p>	
	Videos	<p>60 Second Adventures in Thought  <a href="https://www.youtube.com/playlist?list=PL73A886F2DD959FF1">https://www.youtube.com/playlist?list=PL73A886F2DD959FF1</a>            Six very short clips introducing you to some of the big ideas in philosophy, mathematics and physics which are, at a fundamental level, very similar disciplines. They may be only 60 seconds long, but I find I have to listen to them twice to understand them fully.</p> <p>Numberphile  <a href="https://www.youtube.com/channel/UCoxcjg-8xIDTYp3uz647V5A">https://www.youtube.com/channel/UCoxcjg-8xIDTYp3uz647V5A</a>            A whole channel devoted to sharing mathematical ideas.</p>	
	Podcasts	<p>More or Less <a href="https://www.bbc.co.uk/sounds/brand/b006qshd">https://www.bbc.co.uk/sounds/brand/b006qshd</a>            Tim Harford explains - and sometimes debunks - the numbers and statistics used in political debate, the news and everyday life</p> <p>The Secrets of Mathematics  <a href="https://podcasts.ox.ac.uk/series/secrets-mathematics">https://podcasts.ox.ac.uk/series/secrets-mathematics</a>            Enter the world of contemporary mathematicians</p>	
	Documentaries	<p>Magic Numbers: Hannah Fry's Mysterious World of Maths            A three part documentary series exploring the mysteries of mathematics.  <a href="https://www.youtube.com/watch?v=cyvDG8qjt-M">https://www.youtube.com/watch?v=cyvDG8qjt-M</a></p> <p>Simon Singh's documentary on Fermat's Last Theorem was so widely acclaimed that, even though first aired in 1995, it has had a lasting impact on those who saw it. It is <i>the</i> classic mathematics documentary and can be viewed here:  <a href="https://www.bbc.co.uk/iplayer/episode/b0074rxx/horizon-19951996-fermats-last-theorem">https://www.bbc.co.uk/iplayer/episode/b0074rxx/horizon-19951996-fermats-last-theorem</a></p> <p>Marcus du Sautoy's The Music of the Primes  <a href="https://www.youtube.com/watch?v=hur5lk8fijA">https://www.youtube.com/watch?v=hur5lk8fijA</a></p> <p>Marcus du Sautoy's The Story of Maths            This series of four programmes explore the history of mathematics. You can watch all four, or just dip in to the programme that most interests you. (My favourite is episode 4 on the nature of infinity – if thinking about infinity doesn't blow your mind, you have not understood it!) Not currently available on iplayer but worth looking out for, or borrow the DVDs from school.</p>	

	<p>Puzzles and Recreational Mathematics</p>	<p>Logic puzzles – Japanese logic puzzles are a great way to stretch your logical thinking skills. Completing harder problems helps to develop the resilience and creative approach needed for proof both in challenging topics at A level and on to degree level mathematics. There are lots of puzzles available online. As well as the well-known sudoku, try kakuro, killer sudoku and hanjie.</p> <p>Nrich has a wealth of puzzles and activities to keep your mind active:  <a href="https://nrich.maths.org/14571">https://nrich.maths.org/14571</a></p> <p>How about joining a mathematics MOOC? They are free to access, but additional features such as tests can be unlocked with payment. There is one on recreational mathematics here:  <a href="https://www.futurelearn.com/courses/recreational-math">https://www.futurelearn.com/courses/recreational-math</a></p>													
	<p>Films</p>	<table border="0"> <tr> <td>A Beautiful Mind</td> <td>The story of game theorist John Nash</td> </tr> <tr> <td>Good Will Hunting</td> <td>Mathematics is more of a back drop in this one but still a good film</td> </tr> <tr> <td>Hidden Figures</td> <td>The story of the NASA mathematicians who helped launch John Glenn into space</td> </tr> <tr> <td>The Imitation Game</td> <td>The story of how cryptologist Alan Turing cracked the enigma code, shortening the second world war, including King Ecgbert alumnus, Matthew Beard</td> </tr> <tr> <td>The Man who Knew Infinity</td> <td>The story of self-taught mathematician Ramanujan who collaborated with GH Hardy to produce some of the strangest results in Number Theory</td> </tr> <tr> <td>The Theory of Everything</td> <td>Stephen Hawking may be more of a physicist than a mathematician, but it's a wonderful film, and the list would be incomplete without it</td> </tr> </table>	A Beautiful Mind	The story of game theorist John Nash	Good Will Hunting	Mathematics is more of a back drop in this one but still a good film	Hidden Figures	The story of the NASA mathematicians who helped launch John Glenn into space	The Imitation Game	The story of how cryptologist Alan Turing cracked the enigma code, shortening the second world war, including King Ecgbert alumnus, Matthew Beard	The Man who Knew Infinity	The story of self-taught mathematician Ramanujan who collaborated with GH Hardy to produce some of the strangest results in Number Theory	The Theory of Everything	Stephen Hawking may be more of a physicist than a mathematician, but it's a wonderful film, and the list would be incomplete without it	
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Books	<p>Apostolos Doxiadis                      Uncle Petros and Goldbach's Conjecture A novel with mathematics as an underlying theme.</p> <p>Marcus du Sautoy                      The Music of the Primes Du Sautoy has the ability to explain complex ideas simply. This book, about the building blocks of mathematics and Number Theory, also talks about the tantalising subject of unsolved problems in mathematics.</p> <p>Marcus du Sautoy                      Finding Moonshine Fantastic! Accessibly written and covering a wide range of topics. Essentially about symmetry and group theory, this book also explains what a mathematician does all day. I wish it had been written 20 years ago.</p> <p>Hannah Fry                              Hello World How to be human in the age of the machine – this book explores algorithms in the world around us.</p> <p>James Gleick                              Chaos: Making a New Science A description of the mysterious world of fractals and their applications to Chaos Theory, an extension of mechanics in which simple and complex causes interact, this book covers the big ideas in the study of chaos and the people behind its development.</p> <p>G H Hardy                                  A Mathematician's Apology Refreshingly short. A must-read for anyone serious about mathematics</p> <p>Douglas G Hofstadter    Godel, Escher, Bach: An Eternal Golden Braid A quirky look at the links between Mathematics, computer programming, logic, music, art. Chapters are interspersed with parodies on the work of Lewis Carroll. A love-it or hate-it book.</p> <p>Edward Hurst                              Bridging the Gap to University Mathematics</p> <p>Simon Singh                              Fermat's Last Theorem Fermat's Last Theorem was one of the most famous mathematical conundrums until in 1993 it was proved by Andrew Wiles. This book, stemming from the BBC Horizon film, talks about the history of the problem and gives biographical details of the characters involved in its solution.</p> <p>Simon Singh                              The Code Book The Code Book traces the fascinating development of codes and code-breaking from military espionage in Ancient Greece to modern computer ciphers, to reveal how the remarkable science of cryptography has often changed the course of history. With the Information Age bringing the possibility of a truly unbreakable code ever nearer, and cryptography one of the major debates of our times, Singh investigates the challenge that technology has brought to personal privacy today.</p> <p>Simon Singh                              The Simpsons and their Mathematical Secrets This is a bit more light-hearted but has some good maths in it. The chapters on Futurama (made by the same people as the Simpsons) are particularly good - one writer proved a new theorem especially for the plot an episode!</p> <p>A much more comprehensive list of recommended reading is available here (but the maths department haven't read all of them!): <a href="https://nrich.maths.org/9477">https://nrich.maths.org/9477</a></p>	
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