

Evariste Galois

Born: 25 Oct 1811 in Bourg La Reine (near Paris), France

Died: 31 May 1832 in Paris, France

Evariste Galois' father Nicholas Gabriel Galois and his mother Adelaide Marie Demante were both intelligent and well educated in philosophy, classical literature and religion. However there is no sign of any mathematical ability in any of Galois' family. His mother served as Galois' sole teacher until he was 12 years old. She taught him Greek, Latin and religion where she imparted her own scepticism to her son. Galois' father was an important man in the community and in 1815 he was elected mayor of Bourg-la-Reine.

The starting point of the historical events which were to play a major role in Galois' life is surely the storming of the Bastille on 14 July 1789. From this point the monarchy of Louis 16th was in major difficulties as the majority of Frenchmen composed their differences and united behind an attempt to destroy the privileged establishment of the church and the state.

Despite attempts at compromise Louis 16th was tried after attempting to flee the country. Following the execution of the King on 21 January 1793 there followed a reign of terror with many political trials. By the end of 1793 there were 4595 political prisoners held in Paris. However France began to have better times as their armies, under the command of Napoleon Bonaparte, won victory after victory.

Napoleon became first Consul in 1800 and then Emperor in 1804. The French armies continued a conquest of Europe while Napoleon's power became more and more secure. In 1811 Napoleon was at the height of his power. By 1815 Napoleon's rule was over. The failed Russian campaign of 1812 was followed by defeats, the Allies entering Paris on 31 March 1814. Napoleon abdicated on 6 April and Louis XVIII was installed as King by the Allies. The year 1815 saw the famous one hundred days. Napoleon entered Paris on March 20, was defeated at Waterloo on 18 June and abdicated for the second time on 22 June. Louis XVIII was reinstated as King but died in September 1824, Charles X becoming the new King.

Galois was by this time at school. He had enrolled at the Lycée of Louis-le-Grand as a boarder in the 4th class on 6 October 1823. Even during his first term there was a minor rebellion and 40 pupils were expelled from the school. Galois was not involved and during 1824-25 his school record is good and he received several prizes. However in 1826 Galois was asked to repeat the year because his work in rhetoric was not up to the required standard.

February 1827 was a turning point in Galois' life. He enrolled in his first mathematics class, the class of M. Vernier. He quickly became absorbed in mathematics and his director of studies wrote

It is the passion for mathematics which dominates him, I think it would be best for him if his parents would allow him to study nothing but this, he is wasting his time here and does nothing but torment his teachers and overwhelm himself with punishments.

Galois' school reports began to describe him as *singular, bizarre, original* and *closed*. It is interesting that perhaps the most original mathematician who ever lived should be criticised for being *original*. M. Vernier reported however

Intelligence, marked progress but not enough method.

In 1828 Galois took the examination of the École Polytechnique but failed. It was the leading University of Paris and Galois must have wished to enter it for academic reasons. However, he also wished to enter this school because of the strong political movements that existed among its students, since Galois followed his parents example in being an ardent republican.

Back at Louis-le-Grand, Galois enrolled in the mathematics class of Louis Richard. However he worked more and more on his own researches and less and less on his schoolwork. He studied Legendre's *Géométrie* and the treatises of Lagrange. As Richard was to report

This student works only in the highest realms of mathematics.

In April 1829 Galois had his first mathematics paper published on continued fractions in the *Annales de mathématiques*. On 25 May and 1 June he submitted articles on the algebraic solution of equations to the Académie des Sciences. Cauchy was appointed as referee of Galois' paper.

Tragedy was to strike Galois for on 2 July 1829 his father committed suicide. The priest of Bourg-la-Reine forged Mayor Galois' name on malicious forged epigrams directed at Galois' own relatives. Galois' father was a good natured man and the scandal that ensued was more than he could stand. He hanged himself in his Paris apartment only a few steps from Louis-le-Grand where his son was studying. Galois was deeply affected by his father's death and it greatly influenced the direction his life was to take.

A few weeks after his father's death, Galois presented himself for examination for entry to the École Polytechnique for the second time. For the second time he failed, perhaps partly because he took it under the worst possible circumstances so soon after his father's death, partly because he was never good at communicating his deep mathematical ideas. Galois therefore resigned himself to enter the École Normale, which was an annex to Louis-le-Grand, and to do so he had to take his Baccalaureate examinations, something he could have avoided by entering the École Polytechnique.

He passed, receiving his degree on 29 December 1829. His examiner in mathematics reported:-

This pupil is sometimes obscure in expressing his ideas, but he is intelligent and shows a remarkable spirit of research.

His literature examiner reported:-

This is the only student who has answered me poorly, he knows absolutely nothing. I was told that this student has an extraordinary capacity for mathematics. This astonishes me greatly, for, after his examination, I believed him to have but little intelligence.

Galois sent Cauchy further work on the theory of equations, but then learned from *Bulletin de Férussac* of a posthumous article by Abel which overlapped with a part of his work. Galois then took Cauchy's advice and submitted a new article *On the condition that an equation be soluble by radicals* in February 1830. The paper was sent to Fourier, the secretary of the Paris Academy, to be considered for the Grand Prize in mathematics. Fourier died in April 1830 and Galois' paper was never subsequently found and so never considered for the prize.

Galois, after reading Abel and Jacobi's work, worked on the theory of elliptic functions and abelian integrals. With support from Jacques Sturm, he published three papers in *Bulletin de Férussac* in April 1830. However, he learnt in June that the prize of the Academy would be awarded the Prize jointly to Abel (posthumously) and to Jacobi, his own work never having been considered.

July 1830 saw a revolution. Charles 10th fled France. There was rioting in the streets of Paris and the director of École Normale, M. Guigniault, locked the students in to avoid them taking part. Galois tried to scale the wall to

join the rioting but failed. In December 1830 M. Guigniault wrote newspaper articles attacking the students and Galois wrote a reply in the *Gazette des Écoles*, attacking M. Guigniault for his actions in locking the students into the school. For this letter Galois was expelled and he joined the Artillery of the National Guard, a Republican branch of the militia. On 31 December 1830 the Artillery of the National Guard was abolished by Royal Decree since the new King Louis-Phillipe felt it was a threat to the throne.

Two minor publications, an abstract in *Annales de Gergonne* (December 1830) and a letter on the teaching of science in the *Gazette des Écoles* (2 January 1831) were the last publications during his life. In January 1831 Galois attempted to return to mathematics. He organised some mathematics classes in higher algebra which attracted 40 students to the first meeting but after that the numbers quickly fell off. Galois was invited by Poisson to submit a third version of his memoir on equation to the Academy and he did so on 17 January.

On 18 April Sophie Germain wrote a letter to her friend the mathematician Libri which describes Galois' situation.

.. the death of M. Fourier, have been too much for this student Galois who, in spite of his impertinence, showed signs of a clever disposition. All this has done so much that he has been expelled form École Normale. He is without money... . They say he will go completely mad. I fear this is true.

Late in 1830 19 officers from the Artillery of the National Guard were arrested and charged with conspiracy to overthrow the government. They were acquitted and on 9 May 1831 200 republicans gathered for a dinner to celebrate the acquittal. During the dinner Galois raised his glass and with an open dagger in his hand appeared to make threats against the King, Louis-Phillipe. After the dinner Galois was arrested and held in Sainte-Pélagie prison. At his trial on 15 June his defence lawyer claimed that Galois had said

To Louis-Phillipe, if he betrays

but the last words had been drowned by the noise. Galois, rather surprisingly since he essentially repeated the threat from the dock, was acquitted.

The 14th of July was Bastille Day and Galois was arrested again. He was wearing the uniform of the Artillery of the National Guard, which was illegal. He was also carrying a loaded rifle, several pistols and a dagger. Galois was sent back to Sainte-Pélagie prison. While in prison he received a rejection of his memoir. Poisson had reported that:-

His argument is neither sufficiently clear nor sufficiently developed to allow us to judge its rigour.

He did, however, encourage Galois to publish a more complete account of his work. While in Sainte-Pélagie prison Galois attempted to commit suicide by stabbing himself with a dagger but the other prisoners prevented him. While drunk in prison he poured out his soul

Do you know what I lack my friend? I confide it only to you: it is someone whom I can love and love only in spirit. I have lost my father and no one has ever replaced him, do you hear me...?

In March 1832 a cholera epidemic swept Paris and prisoners, including Galois, were transferred to the pension Sieur Faultrier. There he apparently fell in love with Stephanie-Felice du Motel, the daughter of the resident physician. After he was released on 29 April Galois exchanged letters with Stephanie, and it is clear that she tried to distance herself from the affair.

The name Stephanie appears several times as *a marginal note* in one of Galois' manuscripts.

Galois fought a duel with Perscheux d'Herbinville on 30 May, the reason for the duel not being clear but certainly linked with Stephanie.

You can see *a note in the margin* of the manuscript that Galois wrote the night before the duel.

The note reads

There is something to complete in this demonstration. I do not have the time. (Author's note).

It is this which has led to the legend that he spent his last night writing out all he knew about group theory. This story appears to have been exaggerated.

Galois was wounded in the duel and was abandoned by d'Herbinville and his own seconds and found by a peasant. He died in Cochin hospital on 31 May and his funeral was held on 2 June. It was the focus for a Republican rally and riots followed which lasted for several days.

Galois' brother and his friend Chevalier copied his mathematical papers and sent them to Gauss, Jacobi and others. It had been Galois' wish that Jacobi and Gauss should give their opinions on his work. No record exists of any comment these men made. However the papers reached Liouville who, in September 1843, announced to the Academy that he had found in Galois' papers a concise solution

...as correct as it is deep of this lovely problem: Given an irreducible equation of prime degree, decide whether or not it is soluble by radicals.

Liouville published these papers of Galois in his Journal in 1846.

The theory that Galois outlined in these papers is now called Galois theory.

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