Sir Isaac Newton 1642 – 1727

Out of about 60,000 pages of original work by Isaac Newton only between 3 to 4,000 pages are to do with mathematics. In his lifetime he was known for his Mathematics, through the publication of 'Principia' and 'Optiks'. Newton also wrote three papers on calculus that he never published but which were circulated in the English mathematical community. The main bulk of his work he kept quiet about which was on alchemy, religion and the occult.

Newton applied himself to the study of curves. He started with a thorough study of Descartes' 'La Geometrie'. In the mid 1660's Newton attempted to classify all curves of the third order (cubic):

$$Ax^3 + Bx^2 + Cxy^2 + Dy^3 + Ex^2 + Fxy + Gy^2 + Hx + Jy + K = 0$$

In the same sense that conic sections came in three types (ellipses, parabolas and hyperbolas) so cubics come in 78 different types. Whereas second order curves are sections of just one shape the conic so third order curves are obtainable as the shadow of five shapes. Despite the fact that Newton used mainly algebra in the pursuit of investigating cubic curves he would prove himself to be intrinsically more inclined to geometry.

These classifications of cubic curves, he published as an appendix to his work 'Optiks' but not until 1704. The reason for this he gives is that any cubic can be obtained as the shadow as one of five basic cubics when under projection from a point source of light.

Newton did a lot of work with light, as a break from Greek tradition he was a great experimenter. By using two prisms Newton showed that white light was a mixture of colours whereas red light and blue light once refracted from white light would not refract through the second prism into any other colour. This was proof that red and blue were both pure colours of light. He also discovered that by combining these colours white light was produced.

'Principia' was originally written in Latin and published in 1687. Its impact on the mathematical community at that time can not be overstated. Through the three editions of 'Principia' that were published in Newton’s lifetime, he was very much a celebrity of his time and it was fashionable to own a copy of his work though maybe not so widely understood. Although 'Principia' was written in the Greek geometric style without any calculus it was to serve latter to spur other mathematicians to do calculus.

At the heart of 'Principia' is Newton’s three laws of motion:

Law I
Everybody continues in a state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it.

This law is most evident when considered in space because once a body is in motion it just keeps on moving in uniform motion.

Law II
The change of motion is proportional to the motive force impressed; and is made in the direction of a right line in which that force is impressed.

This means that in order to accelerate or decelerate, a force must act upon a body.

Law III
To every action there is always opposed an equal reaction: or, the mutual action of two bodies upon each other are always equal, and directed to contrary parts.

A good example of this is where gravity pushes down on a body and so an equal and opposite force pushes up which is the ground it rests on.

'Principia' came in three books:

Book I The Motions Of Bodies

Book II The Motions Of Bodies (in resisting mediums)

Book III The System of the world (in mathematical treatment), where world means universe, and was a super conclusion in 'Principia' that really explains why Kepler's rules are what they are.

Newton worked on the basic ideas of calculus between late 1664 to late 1666. At least three forms were written up suitable for publication, but for various reasons never did get published. His powerful new methods did get circulated within the English mathematical community with three manuscripts; 'The October 1666 Tract On Fluxions', 'De analysi per aequationes numero terminorum infinitas' (On Analysis by Equations with Infinitely Many Terms) of 1669, and 'Tractatus de methodis serierum et fluxionum' (A Treatise on the Methods of Series and Fluxions) of 1671.

Out of reading Wallis's 'Arithmetica infinitorum' Newtons discovery of the power series came about. Newton looked at a sequence of curves similar to those that Wallis looked at as below (using modern notation):

$$\left(1 - x^2\right)^n$$

$$\left(1 - x^2\right)^0 = 1$$

$$\left(1 - x^2\right)^1 = 1 - x^2$$

$$\left(1 - x^2\right)^2 = 1 - 2x^2 + x^4$$

$$\left(1 - x^2\right)^3 = 1 - 3x^2 + 3x^4 - x^6$$

$$\left(1 - x^2\right)^4 = 1 - 4x^2 + 6x^4 - 4x^6 + x^8$$

Instead of looking at various numerical values for areas as Willis did, Newton looked at the coefficients of these results. He produced a table where he found Pascal’s triangle placed within the coefficients.

Pascal's Triangle

1					
1	1				
1	2	1			
1	3	3	1		
1	4	6	4	1	
1	5	10	10	5	1

$$\int 1\,dx = x$$

$$\int 1 - x^2\,dx = x - \frac{1}{3}\cdot x^3$$

$$\int 1 - 2x^2 + x^4\,dx = x - \frac{2}{3}\cdot x^3 + \frac{1}{5}\cdot x^5$$

$$\int 1 - 3x^2 + 3x^4 - x^6\,dx = x - x^3 + \frac{3}{5}\cdot x^5 - \frac{1}{7}\cdot x^7$$

$$\int 1 - 4x^2 + 6x^4 - 4x^6 + x^8\,dx = x - \frac{4}{3}\cdot x^3 + \frac{6}{5}\cdot x^5 - \frac{4}{7}\cdot x^7 + \frac{1}{9}\cdot x^9$$

Newton could now expand the formula for the unit circle into a power series:

$$y = \left(1 - x^2\right)^{\frac{1}{2}}$$

By using Pascal's formula:

$$(n,k) = \frac{n(n-1)(n-2)\,..(n-k+1)}{k!}$$

$$\binom{\frac{1}{2}}{0} = 0! = 1$$

$$\binom{\frac{1}{2}}{1} = \frac{\left(\frac{1}{2}-0\right)}{1!} = \frac{1}{2}$$

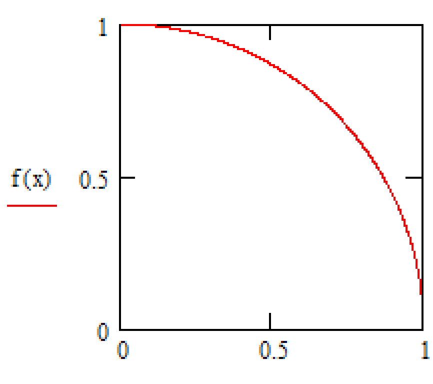
$$\binom{\frac{1}{2}}{2} = \frac{\left(\frac{1}{2}-0\right)\left(\frac{1}{2}-1\right)}{2!} = \frac{-1}{8}$$

$$\binom{\frac{1}{2}}{3} = \frac{\left(\frac{1}{2}-0\right)\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)}{3!} = \frac{1}{16}$$

$$\binom{\frac{1}{2}}{4} = \frac{\left(\frac{1}{2}-0\right)\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)\left(\frac{1}{2}-3\right)}{4!} = \frac{-5}{128}$$

$$\binom{\frac{1}{2}}{5} = \frac{\left(\frac{1}{2}-0\right)\left(\frac{1}{2}-1\right)\left(\frac{1}{2}-2\right)\left(\frac{1}{2}-3\right)\left(\frac{1}{2}-4\right)}{5!} = \frac{7}{256}$$

$f(x) := \left(1-x^2\right)^{\frac{1}{2}}$ where $0 \le x \le 1$



Finding the area above using six terms of an infinite power series:

$$\int \left(1 - x^2\right)^{\frac{1}{2}} dx = (1)\frac{x}{1} - \left(\frac{1}{2}\right)\frac{x^3}{3} - \left(\frac{1}{8}\right)\frac{x^5}{5} - \left(\frac{1}{16}\right)\frac{x^7}{7} - \left(\frac{5}{128}\right)\frac{x^9}{9} - \left(\frac{7}{256}\right)\frac{x^{11}}{11}$$

$$\int_0^1 \left(1 - x^2\right)^{\frac{1}{2}} dx = (1)\frac{1}{1} - \left(\frac{1}{2}\right)\frac{1}{3} - \left(\frac{1}{8}\right)\frac{1}{5} - \left(\frac{1}{16}\right)\frac{1}{7} - \left(\frac{5}{128}\right)\frac{1}{9} - \left(\frac{7}{256}\right)\frac{1}{11}$$

$$= 1 - \frac{1}{6} - \frac{1}{40} - \frac{1}{112} - \frac{5}{1152} - \frac{7}{2816}$$

$$= 0.7925786887$$

On checking the result the answer should be:

$$\frac{\pi}{4} = 0.785398163$$

Between Isaac Newton and Gottfried Leibnitz, the recognition for the invention for calculus is full of controversy. Both men were members of the royal society, they corresponded between each other but never met. Newton did write to Leibnitz giving out information relating to calculus, but was not very generous, revealing little of his methods. In 1684 Leibnitz published a short paper on calculus. This was the first publication regarding calculus, despite the fact that Newton had written about this subject over twenty years earlier, but without publishing it. Newton was not a man willing to share his invention and the politics that ensued this publication saw bitter attacks on Leibnitz. A committee was set up. The committee was anonymously full of Newton supporters. The committee was totally under the influence of Newton, though this was not known at the time, also the report that was written at the time was written by Newton himself which did not favour Leibnitz. Newton was the president of the royal society with a great following. He appears to have won the battle for recognition and yet the irony is that the notation of Leibnitz seems to have survived the test of time to this present time, Newton's fluxions and fluons have fallen by the wayside.

Newton died in March 1727, Voltaire comments a year latter on the comparisons between Descartes and Newton, calling Newton 'destroyer of the Cartesian system'. This is significant coming from a Frenchman. The Cartesians believed that everything moved by impulsion, whereas the Newtonians believed in gravitation. Descartes also thought that volume on its own makes up matter, whereas Newton believes that there also has to be solidarity. Voltaire also writes that 'Newton lived honoured by his compatriots and was buried like a king who had done well by his subject'.

In the light of modern scholarship it has been found that within the primary source of Newton's paper work most of his 60,000 pages of original work was on the occult, religion and alchemy showing Newton as a secret heretic. He believed in Unitarianism an orthodox view, also as an alchemist he would have been discredited.

Newton denied the divinity of Jesus and the holy ghost, this was classed as heresy. At that time English universities were very much a part of Christianity. At various steps in his career at Cambridge he swore oaths to avow his faith but in 1675 he felt he could no longer affirm his orthodoxy. He would not take a false oath and was prepared to resign. King James II came to his rescue. At the last moment Newton was granted a dispensation and so did not have to take holy orders.

Long after Newton's death his papers were reassembled by Whiteside, they showed him to be a secret alchemist. instead of taking the path of chemistry, a science that uses logic and rigour, he chose the disreputed world of alchemy that would have made him look like a charlatan if anyone had known.

Newton's work does seem to be the representation of a style of modern scientific thinking full of reason and credibility while lurking beneath was always this body of work even more prolific that harked back to old ideas so blatantly out-dated even in Newton's time that he would need to keep it a secret.

All source information for this essay comes from the Open University course source book, course unit books and A History Of Mathematics by Victor J Katz.

Written by Adrian Cox 2004