# Sir Isaac Newton

**Isaac Newton**'s life can be divided into three quite distinct periods. The first is his boyhood days from 1643 up to his appointment to a chair in 1669. The second period from 1669 to 1687 which was the highly productive period in which he was a professor at Cambridge University. The third period (nearly as long as the other two combined) saw Newton as a highly paid government official in London with little further interest in mathematical research.

Isaac Newton was born in the manor house of WoolsThorpe, near Grantham in Lincolnshire. By the calendar in use at the time of his birth he was born on Christmas Day 1642. Isaac Newton came from a family of farmers but never knew his father, also named Isaac Newton. Although Isaac's father owned property and animals, which made him quite a wealthy man, he was completely uneducated and could not sign his own name.

Isaac's mother Hannah Ayscough remarried Barnabas Smith the minister of the church at North Witham, a nearby village, when Isaac was two years old. The young child was then left in the care of his grandmother Margery at Woolsthorpe. Basically treated as an orphan, Isaac did not have a happy childhood. His grandfather James was never mentioned by Isaac in later life and the fact that James left nothing to Isaac in his will, made when the boy was ten years old, suggests that there was no love lost between the two. There is no doubt that Isaac felt very bitter towards his mother and his stepfather Barnabas Smith. When examining his sins at age nineteen, Isaac listed: -

> *Threatening my father and mother Smith to burn them and the house over them.*

Upon the death of his stepfather in 1653, Newton lived in an extended family consisting of his mother, his grandmother, one half-brother, and two half-sisters. From shortly after this time Isaac began attending the Free Grammar School in Grantham. Although this was only five miles from his home, Isaac lodged with the Clark family at Grantham. However he seems to have shown little promise in academic work. His school reports described him as 'idle' and 'inattentive'. His mother, by now a lady of reasonable wealth and property, thought that her eldest son was the right person to manage her affairs and her estate. Isaac was taken away from school but soon showed that he had no talent, or interest, in managing an estate. An uncle, William Ayscough, decided that Isaac should prepare for entering university and, having persuaded his mother that this was the right thing to do, Isaac was allowed to return to the Free Grammar School in Grantham in 1660 to complete his school education. This time he lodged with Stokes, who was the headmaster of the school, and it would appear that, despite suggestions that he had previously shown no academic promise; Isaac must have convinced some of those around him that he had academic promise. Some evidence points to Stokes also persuading Isaac's mother to let him enter university, so it is likely that Isaac had shown more promise in his first spell at the school than the school reports suggest.

Newton's aim at Cambridge was a law degree. Instruction at Cambridge was dominated by the philosophy of Aristotle but some freedom of study was allowed in the third year of the course. Newton studied the philosophy of Descartes, Gassendi, and Hobbes and in particular Boyle. The mechanics of the Copernican astronomy of Galileo attracted him and he also studied Kepler's *Optics.* He recorded his thoughts in a book, which he entitled **Quaestiones Quaedam Philosophicae** (Certain Philosophical Questions). It is a fascinating account of how Newton's ideas were already forming around 1664. He headed the text with a Latin statement meaning, "Plato is my friend, Aristotle is my friend, but my best friend is truth" showing himself a free thinker from an early stage.

How Newton was introduced to the most advanced mathematical texts of his day is slightly less clear. According to de Moivre Newton's interest in mathematics began in the autumn of 1663 when he bought an astrology book at a fair in Cambridge and found that he could not understand the mathematics in it. Attempting to read a trigonometry book, he found that he lacked knowledge of geometry and so decided to read Barrow's edition of *Euclid's Elements.* The first few results were so easy that he almost gave up but he changed his mind when he read*:* -

*... Parallelograms upon the same base and between the same parallels are equal.*

Despite some evidence that his progress had not been particularly good, Newton was elected a scholar on 28 April 1664 and received his bachelor's degree in April 1665. It would appear that his scientific genius had still not emerged, but it did so suddenly when the plague closed the University in the summer of 1665 and he had to return to Lincolnshire. There, in a period of less than two years, while Newton was still under 25 years old, he began revolutionary advances in mathematics, optics, physics, and astronomy.

Newton's first work as a Professor was on optics and this was the topic of his first lecture course which begun in January 1670. He had reached the conclusion during the two plague years that white light is not a simple entity. Every scientist since Aristotle had believed that white light was a basic single entity, but the chromatic aberration in a telescope lens convinced Newton otherwise. When he passed a thin beam of sunlight through a glass prism Newton noted the spectrum of colours that was formed.

He argued that white light is really a mixture of many different types of rays which are refracted at slightly different angles, and that each different type of ray produces a different spectral colour. Newton was led by this reasoning to the erroneous conclusion that telescopes using refracting lenses would always suffer chromatic aberration. He therefore proposed and constructed a reflecting telescope.

In 1672 Newton was elected a fellow of the Royal Society after donating a reflecting telescope. Also in 1672 Newton published his first scientific paper on light and colour in the *Philosophical Transactions of the Royal Society.* The paper was generally well

received but Hooke and Huygens objected to Newton's attempt to prove, by experiment alone, that light consists of the motion of small particles rather than waves. The reception that his publication received did nothing to improve Newton's attitude to making his results known to the world. He was always pulled in two directions, there was something in his nature which wanted fame and recognition yet another side of him feared criticism and the easiest way to avoid being criticised was to publish nothing. Certainly one could say that his reaction to criticism was irrational, and certainly his aim to humiliate Hooke in public because of his opinions was abnormal. However, perhaps because of Newton's already high reputation, his corpuscular theory reigned until the wave theory was revived in the 19th century.

Newton's greatest achievement was his work in physics and celestial mechanics, which culminated in the theory of universal gravitation. By 1666 Newton had early versions of his three laws of motion. He had also discovered the law giving the centrifugal force on a body moving uniformly in a circular path. However he did not have a correct understanding of the mechanics of circular motion.

Over a year later (1687) Newton published the *Principia*, perhaps the greatest scientific book ever written. Newton analysed the motion of bodies in resisting and non-resisting media under the action of centripetal forces. The results were applied to orbiting bodies, projectiles, pendulums, and free-fall near the Earth. He further demonstrated that the planets were attracted toward the Sun by a force varying as the inverse square of the distance and generalised that all heavenly bodies mutually attract one another.

Further generalisation led Newton to the law of universal gravitation: -

> *... All matter attracts all other matter with a force proportional to the product of their masses and inversely proportional to the square of the distance between them.*

Newton explained a wide range of previously unrelated phenomena: the eccentric orbits of comets, the tides and their variations, the precession of the Earth's axis, and motion of the Moon as perturbed by the gravity of the Sun. This work made Newton an international leader in scientific research. The Continental scientists certainly did not accept the idea of action at a distance and continued to believe in Descartes' vortex theory where forces work through contact. However this did not stop the universal admiration for Newton's technical expertise.

After suffering a second nervous breakdown in 1693, Newton retired from research. The reasons for this breakdown have been discussed by his biographers and many theories have been proposed: chemical poisoning as a result of his alchemy experiments; frustration with his researches; the ending of a personal friendship with Fatio de Duillier, a Swiss-born mathematician resident in London; and problems resulting from his religious beliefs. Newton himself blamed lack of sleep but this was almost certainly a symptom of the illness rather than the cause of it. There seems little reason to suppose that the illness was anything other than depression, a mental illness he must have suffered

from throughout most of his life, perhaps made worse by some of the events I have just listed.

Newton decided to leave Cambridge to take up a government position in London becoming Warden of the Royal Mint in 1696 and Master in 1699. However, he did not resign his positions at Cambridge until 1701. As Master of the Mint, adding the income from his estates, we see that Newton became a very rich man. For many people a position such as Master of the Mint would have been treated as simply a reward for their scientific achievements. Newton did not treat it as such and he made a strong contribution to the work of the Mint. He led it through the difficult period of recoinage and he was particularly active in measures to prevent counterfeiting of the coinage. In 1703 he was elected president of the Royal Society and was re-elected each year until his death. He was knighted in 1705 by Queen Anne, the first scientist to be so honoured for his work.