Robert Boyle

Born: 25 Jan 1627 in Lismore, County Waterford, Ireland
Died: 30 Dec 1691 in London, England

Robert Boyle was born into a Protestant family. His father was Richard Boyle, Earl of Cork, who had left England in 1588 at the age of 22 and gone to Ireland. Appointed clerk of the council of Munster by Elizabeth I in 1600, he bought Sir Walter Raleigh's estates in the counties of Cork, Waterford, and Tipperary two years later. Robert's mother, Catherine Fenton, was Richard Boyle's second wife, his first having died within a year of the birth of their first child. Robert was the seventh son (and fourteenth child) of his parents fifteen children (twelve of the fifteen survived childhood). Richard Boyle was in his 60s and Catherine Boyle in her 40s when Robert was born. Of his father Robert would later write [12]:-

He, by God's blessing on his prosperous industry, from very inconsiderable beginnings, built so plentiful and so eminent a fortune, that his prosperity has found many admirers, but few parallels.

Indeed, Robert was fortunate to have the richest man in Great Britain for a father although, one would have to say, the Earl of Cork had acquired his fortune by somewhat dubious means. He was imprisoned in England on charges of embezzlement at one stage and later was fined heavily for possessing defective titles to some of his estates.

The Earl of Cork and his wife believed that the best upbringing for young children, up to the time they began their education, could be provided away from their parents. Robert was sent away to be brought up in the country while his father continued to aim for higher and higher political success. The Earl of Cork lived for four years in his town house in Dublin. He was appointed a lord high justice in 1629 and lord high treasurer in 1631. However, during this time in Dublin Robert's mother died and some time after this Robert returned from his stay with his country nurse to rejoin his family.

Robert was sent, together with one of his brothers, to study at Eton College in England in 1635. At this time the school was becoming fashionable as a place where important people sent their sons. The headmaster was John Harrison and the two young Boyle brothers lived in the headmaster's house [10]:-

Besides the strictly classical course of study then in vogue, the boys had private tutors in French, dancing, and music, for whom they paid extra fees.

Boyle paid tribute to Harrison in [12] where he writes that Harrison gave him a:-

... strong passion to acquire knowledge ...

At this stage of his time at Eton, Boyle's education was clearly going well. He was popular with both his headmaster and his fellow pupils. However, perhaps he had been given too much special attention by Harrison for, when Harrison retired, Boyle seemed unable to fit in with the educational discipline the new headmaster brought to the school. Realising that neither of his sons were progressing well at school under the new headmaster, the Earl of Cork took his sons away from the Eton in November 1638. After this Boyle was tutored privately by one of his father's chaplains.

At the age of 12 Boyle was sent by his father, with one of his brothers, on a European tour. From Dieppe they travelled to Paris, then on to Lyon before reaching Geneva. In Geneva Boyle studied with a private tutor

French, Latin, rhetoric and religion. He also spent time in the afternoons playing tennis and fencing. Perhaps most importantly of all he began to study mathematics and soon [12]:-

... he grew very well acquainted with the most useful part of arithmetic, geometry, with its subordinates, the doctrine of the sphere, that of the globe, and fortification.

In 1641 Boyle learnt Italian in preparation for visiting there. In September of that year Boyle and his tutor were in Venice, then by the beginning of 1642 they were in Florence. Galileo died in his villa in Arcetri, near Florence, while Boyle was living in the city. He was much influenced by this event and he carefully studied Galileo's works. If any one event shaped Boyle's life and directed him towards science, then it was this. Of course his Protestant background, with an ingrained fear of Jesuits, contributed to his sympathy for Galileo and his treatment by the Roman Catholic Church. Boyle became a strong supporter of Galileo's philosophy and believed strongly from this time in the new approach to studying the world through mathematics and mechanics.

By May 1642 Boyle and his tutor were in Marseilles waiting for money from Boyle's father so that he could complete the journey home. This did not arrive, merely a letter from his father explaining that a rebellion in Munster was fully occupying his time and money. He did send £250 to pay for Boyle's return, but the money never reached him. Boyle returned to Geneva where he seems to have lived mainly on his tutor's earnings, while his father continued to fight the Irish at Lismore Castle. King Charles I negotiated a cease-fire with the Catholic rebels fighting the Earl of Cork so that he might bring his troops back to England to help him in the civil war which had broken out. The Earl of Cork never got over Charles treating the Irish as equals and he died shortly after in September 1643. Robert Boyle was still living in Geneva when his father died. In the summer of 1644 he sold some jewellery and used the money that he was paid to finance his return trip to England.

Back in England, Boyle lived for a while with his sister Katherine. She was thirteen years older than him and was a lady of some importance, married to Viscount Ranelagh. England was in a chaotic state, the civil war which had began in 1642 was being fought between King Charles and the parliament. Charles had moved to Oxford while the parliament had formed a treaty with the Scots. In return for Scots military support they were promised the establishment of a Presbyterian church. Several battles in 1644 left both King and parliament somewhat in disarray. Boyle had property in England, the manor of Stalbridge, left to him by his father but the situation in the country made things difficult. He wrote in a letter (see for example [3]):-

[*I*] *got safe into England towards the middle of the year* 1644, *where we found things in such a confusion, that although the manor of Stalbridge were by my father's decease descended unto me, yet it was near four months before I could get thither.*

In fact although Boyle inspected his new home after four months, it was much longer before he was able to move in. This happened in March 1646 after he had spent more time with his sister and made a return trip to France to repay his debts to his tutor who continued to live there. Although Boyle did not intend to spend long at Stalbridge, he remained there for around six years. He probably studied harder than he admits in a letter sent to his old tutor in France in October 1646 (see for example [3]):-

As for my studies, I have had the opportunity to prosecute them but by fits and snatches, as my leisure and my occasions would give me leave. Divers little essays, both in verse and prose, I have taken pains to scribble upon several subjects. ... The other humane studies I apply myself to, are natural philosophy, the mechanics and husbandry, according to the principles of our new philosophical college ...

This "new philosophical college" is also called by Boyle the "Invisible College" later in the letter. It is the society which would soon became the "Royal Society of London" and it provided Boyle's only contact with the world of science while he lived a somewhat lonely life at Stalbridge. He would look forward to his visits to London where members of the College [3]:-

.. do now and then honour me with their company.

It was discussions in the Invisible College which led to Boyle reading Oughtred's *Clavis Mathematica* as well as the works of Mersenne and Gassendi. Boyle had from the time of his visit to Italy favoured the ideas of Copernicus and he now held these views deeply, together with a deep belief in the atomic theory of matter. In the Invisible College these views were considered to be those of the new natural philosophy.

This period was a difficult one for Boyle for he tried hard not to be forced to take sides in the civil war. His loyalties were somewhat divided, his father having been a staunch Royalist, his sister Katherine a staunch Parliamentarian. Basically he had little sympathy with either side, but the final outcome of the civil war turned out to his advantage. Charles I was defeated and executed but, in 1650, Charles II landed in Scotland and tried to regain power. Cromwell, leading the parliamentary forces, defeated the Scots in 1650, again in 1651, and the Irish were also defeated by Cromwell in 1652. Boyle went to Ireland in 1652 to look after his estates there. He ended up a very rich man when Cromwell apportioned Irish lands to the English colonists. From that time on he was able to devote himself entirely to science without the need to earn money. It should be noted, however, that Boyle was a very generous man with his money, and many around him benefited from this generosity.

Boyle met John Wilkins, the leader of the Invisible College, in London when he visited there in 1653. At this time Wilkins had just been appointed as Warden of Wadham College in Oxford and he was planning to run the Invisible College from there. He strongly encouraged Boyle to join them in Oxford and invited him to live in the College. Boyle decided to go to Oxford but preferred not to accept Wilkins' offer of accommodation, choosing instead to arrange his own rooms where he could carry out his scientific experiments. At Oxford he joined a group of forward looking scientists, including John Wilkins, John Wallis who was the Savilian Professor of Geometry, Seth Ward who was the Savilian Professor of Astronomy, and Christopher Wren who would succeed Ward as Savilian Professor of Astronomy in 1661. From 1654 Boyle lived in Oxford, although he never held any university post.

He made important contributions to physics and chemistry and is best known for Boyle's law (sometimes called Mariotte's Law) describing an ideal gas. Boyle's law appears in an appendix written in 1662 to his work *New Experiments Physio-Mechanicall, Touching the Spring of the Air and its Effects* (1660). The 1660 text was the result of three years of experimenting with an air pump with the help of Hooke who he employed as his assistant. The apparatus had been designed by Hooke and using it Boyle had discovered a whole series of important facts. He had shown, among other things, that sound did not travel in a vacuum, he had proved that flame required air as did life, and he investigated the elastic properties of air.

The 1662 appendix did not only contain Boyle's law which relates volume and pressure in a gas, but it also contained a defence of Boyle's work on the vacuum which appeared in the main text. Many scientists, particularly Hobbes, had argued that a vacuum could not exist and claimed that Boyle's results obtained with the vacuum pump must be the result of some as yet undiscovered force. Another book by Boyle in 1666 was called *Hydrostatic paradoxes.* It is [1]:-

... both a penetrating critique of Pascal's work on hydrostatics, full of acute observations upon Pascal's experimental method, and a presentation of a series of important and ingenious experiments on fluid pressure.

In *The Sceptical Chemist* (1661) Boyle argued against Aristotle's view of the four elements of earth, air, fire and water. He argued that matter was composed of corpuscles which themselves were differently built up of different configurations of primary particles. Although many ideas in this work were taken over from Descartes, in one respect he fundamentally disagreed with him. Boyle's ideas that the primary particles move freely in fluids, less freely in solids, followed Descartes. However, Descartes did not believe in a vacuum, rather he believed in an all pervading ether. Boyle had conducted many experiments which led him to believe in a vacuum and, having found no experimental evidence of the ether, to reject that idea. He did follow Descartes in his overall belief that the world was basically a complex system governed by a small number of simple mathematical laws.

In considering optics, in particular colour, Boyle was not so successful. He published *Experiments and considerations touching colours* in 1664 but was quite prepared to acknowledge that Hooke's work of 1665 was superior and he completely acknowledged that Newton's ideas, published in 1672, should replace his own.

Boyle was a founding fellow of the Royal Society. He published his results on the physical properties of air through this Society. His work in chemistry was aimed at establishing it as a mathematical science based on a mechanistic theory of matter. It is for this reason that we have decided to include Boyle into this archive of mathematicians for, although he did not develop any mathematical ideas himself, he was one of the first to argue that all science should be developed as an application of mathematics. Although others before him had applied mathematics to physics, Boyle was one of the first to extend the application of mathematics to chemistry which he tried to develop as a science whose complex appearance was merely the result on simple mathematical laws applied to simple fundamental particles.

In 1668 Boyle left Oxford and went to live with his sister Lady Ranelagh in London. There he became a neighbour of Barrow but seemed to have more common scientific interests with another neighbour Thomas Sydenham, a physician. In 1669 his sister's husband died. Some however, were keen to find Boyle a wife. Wallis found someone whom he considered particularly suitable to be Boyle's wife and wrote to him saying:-

If I might be the happy instrument in making two so excellent persons happy in each other ... I do not know in what else I could more approve myself.

Boyle seemed to have successfully avoided such attempts to marry him off. In June 1670 he had a stroke which left him paralysed but slowly he recovered his health. He continued to work and to entertain at his London home. Visitors were so frequent that he had to restrict visits so that he had time to continue with his scientific researches, which he did with the help of many excellent assistants.

In 1680 he declined the offer that he serve as President of the Royal Society. He explained his reasons were religious in that he could not swear to necessary oaths. The religious side of Boyle is one which we have not mentioned in this biography, yet it was an important force in his life. Perhaps the reason it has not been necessary to mention his strong Christian faith earlier is that to Boyle there was no conflict with religion and a mechanistic world [1]:-

... for him a God who could create a mechanical universe - who could create matter in motion, obeying certain laws out of which the universe as we know it could come into being in an orderly fashion - was far more to be admired and worshipped than a God who created a universe without scientific law.

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January 2000