

Robert Boyle

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Robert Boyle FRS (25 January 1627 – 31 December 1691) was a 17th century natural philosopher, chemist, physicist, and inventor, also noted for his writings in theology. He is best known for Boyle's law.^[1] Although his research clearly has its roots in the alchemical tradition, he is largely regarded today as the first modern chemist, and therefore one of the founders of modern chemistry. Among his works, *The Sceptical Chymist* is seen as a cornerstone book in the field of chemistry.

Contents

- 1 Early years
- 2 Middle years
- 3 Later years
- 4 Scientific investigator
- 5 Theological interests
- 6 Important works
- 7 See also
- 8 References
- 9 Further reading
- 10 External links

Early years

Boyle was born in Lismore Castle, in County Waterford, Ireland, the seventh son and fourteenth child of Richard Boyle, 1st Earl of Cork. Richard Boyle had arrived in

Robert Boyle



Robert Boyle (1627–91)

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| Born | 25 January 1627 Lismore, County Waterford, Ireland |
| Died | 31 December 1691 (aged 64) London, England |
| Fields | Physics, chemistry |
| Known for | Boyle's law, founder of modern chemistry |
| Influences | Robert Carew, Galileo Galilei, Otto von Guericke, Francis Bacon |
| Influenced | Considered the founder of modern chemistry |
| Notable awards | Fellow of the Royal Society |

Ireland in 1588, obtained an appointment as a deputy escheator, and had amassed enormous landholdings by the time Robert was born.

As a child, Robert was fostered to a local family,^[2] as were his elder brothers. Consequently, the eldest of the Boyle children had sufficient Irish at four years of age to act as a translator for his father.^[3] Robert received private tutoring in Latin, Greek and French and when he was eight years old, following the death of his mother, he was sent to Eton College in England. His father's friend, Sir Henry Wotton, was then the provost of the college.

During this time, his father hired a private tutor, Robert Carew, who had knowledge of Irish, to act as private tutor to his sons in Eton. However, "only Mr. Robert sometimes desires it and is a little entered in it", but despite the "many reasons" given by Mr. Carew to turn their attentions to it, "they practice the French and Latin but they affect not the Irish".^[3] After spending over three years at Eton, Robert traveled abroad with a French tutor. They visited Italy in 1641 and remained in Florence during the winter of that year studying the "paradoxes of the great star-gazer" Galileo Galilei, who was elderly but still living in 1641.

Middle years



Sculpture of a young boy thought to be Boyle on his parents' monument in St. Patrick's Cathedral.

Boyle returned to England from Continental Europe in mid-1644 with a keen interest for scientific research.^[4] His father had died the previous year and had left him the manor of Stalbridge in Dorset, England and substantial estates in County Limerick in Ireland that he had acquired during the Cromwellian War. From that time, Robert devoted his life to scientific research and soon took a prominent place in the band of inquirers, known as the "Invisible College", who devoted themselves to the cultivation of the "new philosophy". They met frequently in London, often at Gresham College, and some of the members also had meetings at Oxford.

Having made several visits to his Irish estates beginning in 1647, Robert moved to Ireland in 1652 but became frustrated at the his inability to progress his work in the country. In one letter, he described Ireland as "a barbarous country where

chemical spirits were so misunderstood and chemical instruments so unprocurable that it was hard to have any Hermetic thoughts in it."^[5] In 1654, Boyle left Ireland for Oxford to pursue his work more successfully.

Reading in 1657 of Otto von Guericke's air-pump, he set himself with the assistance of Robert Hooke to devise improvements in its construction, and with the result, the "machina Boyleana" or "Pneumatical Engine", finished in 1659, he began a series of experiments on the properties of air.^[1] An inscription can be found on the wall of University College, Oxford the High Street at Oxford (now the location of the Shelley Memorial), marking the spot where Cross Hall stood until the early 19th century. It was here that Boyle rented rooms from the wealthy apothecary who owned the Hall.

An account of Boyle's work with the air pump was published in 1660 under the title *New Experiments Physico-Mechanicall, Touching the Spring of the Air, and its Effects...* Among the critics of the views put forward in this book was a Jesuit, Francis Line (1595–1675), and it was while answering his objections that Boyle made his first mention of the law that the volume of a gas varies inversely to the pressure of the gas, which among English-speaking people is usually called after his name.

However, the person that originally formulated the hypothesis was Henry Power in 1661.

Boyle included a reference to a paper written by Power, but mistakenly attributed it to Richard Towneley. In continental Europe the hypothesis is sometimes attributed to Edme Mariotte, although he did not publish it until 1676 and was likely aware of Boyle's work at the time.^[6] In 1663 the Invisible College became the Royal Society of London for the Improvement of Natural Knowledge, and the charter of incorporation granted by Charles II of England, named Boyle a member of the council. In 1680 he was elected president of the society, but declined the honour from a scruple about oaths.

He made a "wish list" of 24 possible inventions which included "The Prolongation of Life", the "Art of Flying", "perpetual light", "making armor light and extremely hard", "A ship to saile with All Winds, and a Ship not to be sunk", "practicable and certain way of finding Longitudes", "potent druggs (sic) to alter or Exalt Imagination, Waking, Memory and other functions and appease pain, procure innocent sleep, harmless dreams etc". They are extraordinary because all but a few of the 24 have come true.^[7]

It was during his time at Oxford that Boyle was a *Chevalier*. The Chevaliers are thought to have been established by royal order a few years before Boyle's time at Oxford. The period of Boyle's residence was marked by the reactionary actions of the victorious parliamentary forces, consequently this period marked the most secretive period of Chevalier movements and thus little is known about Boyle's involvement beyond his membership.

In 1668 he left Oxford for London where he resided at the house of his sister, Lady Ranelagh, in Pall Mall.

Later years

In 1689 his health, never very strong, began to fail seriously and he gradually withdrew from his public engagements, ceasing his communications to the Royal Society, and advertising his desire to be excused from receiving guests, "unless upon occasions very extraordinary", on Tuesday and Friday forenoon, and Wednesday and Saturday afternoon. In the leisure thus gained he wished to "recruit his spirits, range his papers", and prepare some important chemical investigations which he proposed to leave "as a kind of Hermetic legacy to the studious disciples of that art", but of which he did not make known the nature. His health became still worse in 1691, and he died on 31

December that year, just a week after that of the sister with whom he had lived for more than twenty years. Robert Boyle died from paralysis. He was buried in the churchyard of St Martin in the Fields, his funeral sermon being preached by his friend Bishop Gilbert Burnet. In his will, Boyle endowed a series of Lectures which came to be known as the Boyle Lectures.

Scientific investigator



Plaque at the site of Boyle and Hooke's experiments in Oxford. See also The Boyle-Hooke plaque.

Boyle's great merit as a scientific investigator is that he carried out the principles which Francis Bacon espoused in the *Novum Organum*. Yet he would not avow himself a follower of Bacon, or indeed of any other teacher. On several occasions he mentions that in order to keep his judgment as unprepossessed as might be with any of the modern theories of philosophy, until he was "provided of experiments" to help him judge of them, he refrained from any study of the Atomical and the Cartesian systems, and even of the *Novum Organum* itself, though he admits to "transiently consulting" them about a few particulars. Nothing was more alien to his mental temperament than the spinning of hypotheses. He regarded the acquisition of knowledge as an end in itself, and in consequence he gained a wider outlook on the aims of scientific inquiry than had been enjoyed by his predecessors for many centuries. This, however, did not mean that he paid no attention to the practical application of science nor that he despised knowledge which tended to use.



Boyle's air pump.

Boyle was an alchemist; and believing the transmutation of metals to be a possibility, he carried out experiments in the hope of achieving it; and he was instrumental in obtaining the repeal, in 1689, of the statute of Henry IV against multiplying gold and silver. With all the important work he accomplished in physics – the enunciation of Boyle's law, the discovery of the part taken by air in the propagation of sound, and investigations on the expansive force of freezing water, on specific gravities and refractive powers, on crystals, on electricity, on colour, on hydrostatics, etc. – chemistry was his peculiar and favourite study. His first book on the subject was *The Sceptical Chymist*, published in 1661, in which he criticized the "experiments whereby vulgar Spagyrist are wont to endeavour to evince their Salt, Sulphur and Mercury to be the true Principles of Things.". For him chemistry was the science of the composition of substances, not merely an adjunct to the arts of the alchemist or the physician. He endorsed the view of elements as the undecomposable constituents of material bodies; and made the distinction between mixtures and compounds. He made considerable progress in the technique of detecting their ingredients, a process which he designated by the term "analysis". He further supposed that the elements were ultimately composed of particles of various sorts and sizes, into which, however, they were not to be resolved in any known way. He studied

the chemistry of combustion and of respiration, and conducted experiments in physiology, where, however, he was hampered by the "tenderness of his nature" which kept him from anatomical dissections, especially of living animals, though he knew them to be "most instructing".

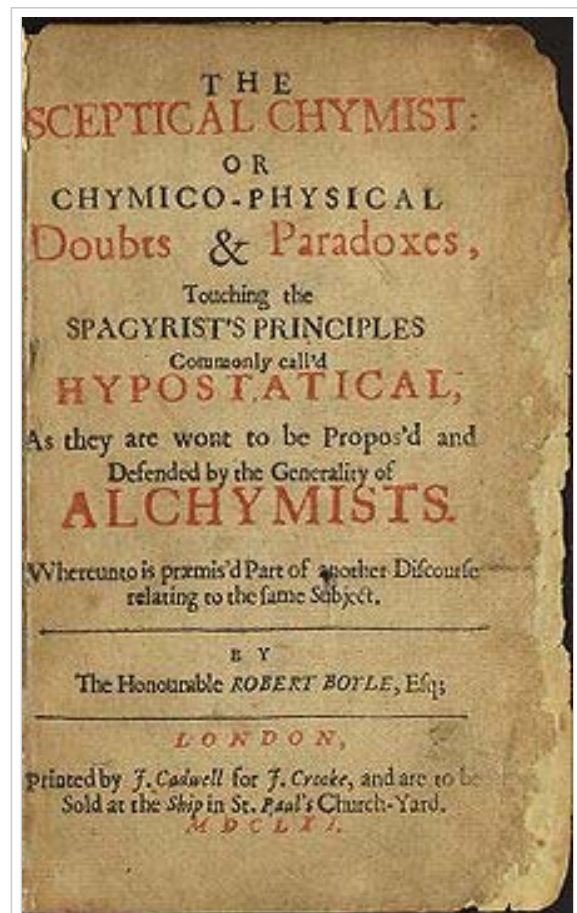
Theological interests

Besides being a busy natural philosopher, Boyle devoted much time to theology, showing a very decided leaning to the practical side and an indifference to controversial polemics. At the Restoration of the king in 1660 he was favourably received at court, and in 1665 would have received the provostship of Eton College, if he would have taken orders; but this he refused to do on the ground that his writings on religious subjects would have greater weight coming from a layman than a paid minister of the Church.

As a director of the East India Company he spent large sums in promoting the spread of Christianity in the East, contributing liberally to missionary societies and to the expenses of translating the Bible or portions of it into various languages. Boyle supported the policy that the Bible should be available in the vernacular language of the people (in contrast to the Latin-only policy of the Roman Catholic church at the time). An Irish language version of the New Testament was published in 1602 but was rare in Boyle's adult life. In 1680—5 Boyle personally financed the printing of the Bible, both Old and New Testaments, in Irish.^[8] In this respect, Boyle's attitude to the Irish language differed from the English Ascendancy class in Ireland at time, which was generally hostile to the language and largely opposed the use of Irish (not only as a language religious worship).^[9]

In his Will, Boyle provided money for a series of lectures to defend the Christian religion against those he considered "notorious infidels, namely atheists, deists, pagans, Jews and Muslims", with the provision that controversies between Christians were not to be mentioned (see Boyle Lectures).^[10]

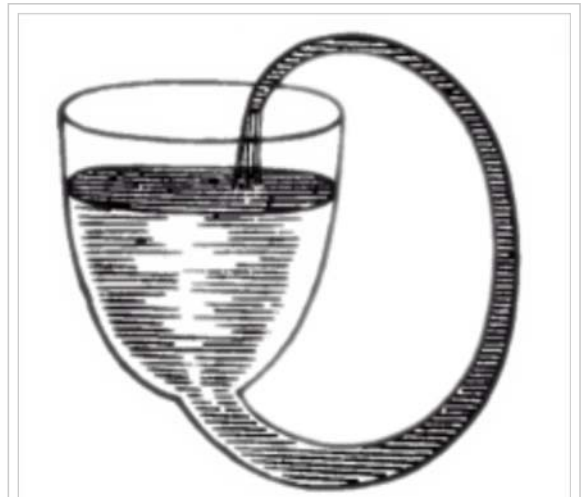
Important works



Title page of *The Sceptical Chymist*
(1661).

The following are some of the more important of his works:

- 1660 – New Experiments Physico-Mechanical: Touching the Spring of the Air and their Effects
- 1661 – The Sceptical Chymist (http://dewey.library.upenn.edu/sceti/printedbooksNew/index.cfm?TextID=boyle_chymist)
- 1663 – Considerations touching the Usefulness of Experimental Natural Philosophy (followed by a second part in 1671)
- 1664 – Experiments and Considerations Touching Colours, with Observations on a Diamond that Shines in the Dark
- 1665 – New Experiments and Observations upon Cold
- 1666 – Hydrostatical Paradoxes ^[12]
- 1666 – Origin of Forms and Qualities according to the Corpuscular Philosophy
- 1669 – a continuation of his work on the spring of air
- 1670 – demonstrated that a reduction in ambient pressure could lead to bubble formation in living tissue. This description of a viper in a vacuum was the first recorded description of decompression sickness. ^[13]
- 1670 – tracts about the Cosmical Qualities of Things, the Temperature of the Subterranean and Submarine Regions, the Bottom of the Sea, &c. with an Introduction to the History of Particular Qualities
- 1672 – Origin and Virtues of Gems
- 1673 – Essays of the Strange Subtilty, Great Efficacy, Determinate Nature of Effluvioms
- 1674 – two volumes of tracts on the Saltiness of the Sea, Suspicions about the Hidden Realities of the Air, Cold, Celestial Magnets, Animadversions on Hobbes's Problemata de Vacuo
- 1676 – Experiments and Notes about the Mechanical Origin or Production of Particular Qualities, including some notes on electricity and magnetism
- 1678 – Observations upon an artificial Substance that Shines without any Preceding Illustration
- 1680 – the Aerial Noctiluca



Boyle's self-flowing flask, a perpetual motion machine, appears to fill itself through siphon action ("hydrostatic perpetual motion" and involves the "hydrostatic paradox"^[11] This is not possible in reality; a siphon requires its "output" to be lower than the "input".

- 1682 – New Experiments and Observations upon the Icy Noctiluca
- 1682 – a further continuation of his work on the air
- 1684 – Memoirs for the Natural History of the Human Blood
- 1685 – Short Memoirs for the Natural Experimental History of Mineral Waters
- 1686 – A Free Enquiry into the Vulgarly Received Notion of Nature (<http://books.google.com/books?id=k5muNiPfRY4C>)
- 1690 – Medicina Hydrostatica
- 1691 – Experimentae et Observationes Physicae

Among his religious and philosophical writings were:

- 1648/1660 – Seraphic Love, written in 1648, but not published until 1660
- 1663 – An Essay upon the Style of the Holy Scriptures
- 1664 – Excellence of Theology compared with Natural Philosophy
- 1665 – Occasional Reflections upon Several Subjects, which was ridiculed by Swift in A Meditation Upon a Broom-Stick, and by Butler in An Occasional Reflection on Dr Charlton's Feeling a Dog's Pulse at Gresham College
- 1675 – Some Considerations about the Reconcilableness of Reason and Religion, with a Discourse about the Possibility of the Resurrection
- 1687 – The Martyrdom of Theodora And Didymus
- 1690 – The Christian Virtuoso

See also

- Ambrose Godfrey, phosphorus manufacturer who started as Boyle's assistant
- Anaerobic digestion, history section
- *An Experiment on a Bird in the Air Pump*, a painting of a demonstration of one of Boyle's experiments
- Boyle temperature, thermodynamic quantity named after Boyle
- Lismore Castle
- List of people on stamps of Ireland
- Pneumatic chemistry
- Timeline of hydrogen technologies
- Bloodhound

References

1. ^a ^b Acott, Chris (1999). "The diving "Law-ers": A brief resume of their lives." (<http://archive.rubicon-foundation.org/5990>) . *South Pacific Underwater Medicine Society journal* **29** (1). ISSN 0813-1988

- (<http://www.worldcat.org/issn/0813-1988>) . OCLC 16986801 (<http://www.worldcat.org/oclc/16986801>) . <http://archive.rubicon-foundation.org/5990>. Retrieved 2009-04-17.
2. ^ McCartney, Mark; Whitaker, Andrew (2003), *Physicists of Ireland: Passion and Precision*, London: Insitute of Physics Publishing
 3. ^ ^a ^b Canny, Nicholas (1982), *The Upstart Earl: a study of the social and mental world of Richard Boyle*, Cambridge: Cambridge University Press, p. 127
 4. ^ See biographies of Robert Boyle at [1] (<http://www.litencyc.com/php/speople.php?rec=true&UID=522>) , [2] (<http://www.woodrow.org/teachers/ci/1992/Boyle.html>) , [3] (<http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Boyle.html>) and [4] (http://books.google.ie/books?id=fjDXtalPeesC&pg=PT24&lpg=PT24&dq=%2Bminority%22robert+boyle%22+continent&source=web&ots=0GoWnMtkTE&sig=w5L_P2i0E6hYobZE7vm9LffWYN4&hl=en) .
 5. ^ quoted in Silver, Brian. *The Ascent of Science*, p. 114. Oxford University Press US, 2000. ISBN 9780195134278
 6. ^ Brush, Stephen G. (2003). *The Kinetic Theory of Gases: An Anthology of Classic Papers with Historical Commentary*. History of Modern Physical Sciences Vol 1. Imperial College Press. ISBN 1860943489.
 7. ^ Robert Boyle's prophetic scientific predictions from the 17th century go on display at the Royal Society ([http://www.telegraph.co.uk/news/uknews/7798012/Robert-Boyles-prophetic-scientific-predictions-](http://www.telegraph.co.uk/news/uknews/7798012/Robert-Boyles-prophetic-scientific-predictions-from-the-17th-century-go-on-display-at-the-Royal-Society.html)
 8. ^ Baines Reed, Talbot (1887), *A History of the Old English Letter Foundries* (<http://www.archive.org/details/ahistoryoldengl00reedgoog/>) , <http://www.archive.org/details/ahistoryoldengl00reedgoog/>, pages 189-190. Also S.L. Greenslade (editor) (1963), *The Cambridge History of the Bible: The West from the Reformation to the Present Day* (<http://books.google.co.uk/books?id=IDFBru3-C8MC&pg=PA172>) , pages 172-173.
 9. ^ Hastings, Adrian (1997), Cambridge: Cambridge University, p. 86
 10. ^ "The Boyle Lecture" (http://www.stmarylebow.co.uk/?Boyle_Lecture) . *St. Marylebow Church*. http://www.stmarylebow.co.uk/?Boyle_Lecture.
 11. ^ Arthur W. J. G. Ord-Hume (2006). *Perpetual Motion: The History of an Obsession* (http://books.google.com/?id=022yYXnS_GQC&pg=PA94&dq=boyle%27s-perpetual-motion-scheme) . Adventures Unlimited Press. ISBN 1931882517. http://books.google.com/?id=022yYXnS_GQC&pg=PA94&dq=boyle%27s-perpetual-motion-scheme.
 12. ^ Cf. Hunter (2009), p.147. "It forms a kind of sequel to *Spring of the Air* ... but although Boyle notes he might have published it as part of an appendix to that work, it formed a self-contained whole, dealing with atmospheric pressure with particular reference to liquid masses"
 13. ^ Acott, C. (1999). "A brief history of diving and decompression illness." (<http://archive.rubicon-foundation.org>

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Further reading

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- Hunter, Michael, *Boyle : Between God and Science*, New Haven : Yale University Press, 2009. ISBN 9780300123814
- Hunter, Michael, *Robert Boyle, 1627-91: Scrupulosity and Science* (http://books.google.com/books?id=3NxSpj_4vp4C&printsec=frontcover) , The Boydell Press, 2000
- Principe, Lawrence, *The Aspiring Adept: Robert Boyle and His Alchemical Quest* (<http://books.google.com/books?id=nsrrMF81RHEC&printsec=frontcover>) , Princeton University Press, 1998
- Shapin, Stephen; Schaffer, Simon, *Leviathan and the Air-Pump*.

Boyle's published works online

- *The Sceptical Chymist* (<http://www.gutenberg.org/etext/22914>) - Project Gutenberg
- *Essay on the Virtue of Gems* (http://www.farlang.com/gemstones/boyle-virtue-gems/page_001) - Gem and Diamond Foundation
- *Experiments and Considerations Touching Colours* (http://www.farlang.com/gemstones/boyle-experiments-colours/page_001) - Gem and Diamond Foundation
- *Experiments and Considerations Touching Colours* (<http://www.gutenberg.org/etext/14504>) - Project Gutenberg
- Boyle Papers (http://www.bbk.ac.uk/boyle/boyle_papers/boylepapers_index.htm) University of London
- *Hydrostatical Paradoxes* (<http://books.google.com/books?id=i3g5AAAacAAJ&printsec=frontcover>) - Google Books

External links

- Robert Boyle (<http://plato.stanford.edu/entries/boyle>) entry by J. J. MacIntosh and Peter Anstey in the *Stanford Encyclopedia of Philosophy*
- O'Connor, John J.; Robertson, Edmund F., "Robert Boyle" (<http://www-history.mcs.st-andrews.ac.uk/Biographies/Boyle.html>) , *MacTutor History of*

Mathematics archive, University of St Andrews, <http://www-history.mcs.st-andrews.ac.uk/Biographies/Boyle.html>.

- Robert Boyle and Robert Hooke (<http://archive.museophile.org/ox/univ-col/boyle-hooke.html>)
- Readable versions of Excellence of the mechanical hypothesis and Origin of forms and qualities (<http://www.earlymoderntexts.com>)
- Robert Boyle Project, Birkbeck, University of London (<http://www.bbk.ac.uk/boyle/>)
- The Boyle's Educational Foundation (<http://www.robert-boyle.co.uk>)
- Summary juxtaposition of Boyle's *The Sceptical Chymist* and his *The Christian Virtuoso* (http://cogweb.ucla.edu/EarlyModern/Boyle_1661.html)
- The Relationship between Science and Scripture in the Thought of Robert Boyle (<http://www.asa3.org/ASA/PSCF/1997/PSCF3-97Woodall.html>)
- Robert Boyle and His Alchemical Quest : Including Boyle's "Lost" Dialogue on the Transmutation of Metals (<http://books.google.com/books?id=nsrrMF81RHEC>) , Princeton University Press, 1998, ISBN 0-691-05082-1
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Categories: 1627 births | 1691 deaths | Alumni of University College, Oxford |

Discoverers of chemical elements | Early modern philosophers | English chemists | English philosophers | English physicists | Fellows of the Royal Society | Gentleman scientists | Irish chemists | Irish philosophers | Irish physicists | Old Etonians | People from County Waterford | Philosophers of science | Priory of Sion hoax

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