



Far from defining the chemical elements, Robert Boyle in fact doubted their existence.

IN RETROSPECT

The Sceptical Chymist

Robert Boyle's widely misunderstood book elevated the status of chemistry, explains **Lawrence Principe**.

It can be said of books, as Shakespeare said of people, that "some are born great, some achieve greatness, and some have greatness thrust upon them". Robert Boyle's *The Sceptical Chymist* (1661) falls into the last category. Widely celebrated as a landmark, it remains misrepresented, misunderstood and unread. It has been praised for opening the way to modern chemistry by sweeping away misguided alchemy and for providing the first modern definition of an element. Yet it did neither. Both Boyle and the book are important, but not for the reasons often cited.

Boyle (1627–91), seventh son of the richest man in Britain, devoted his life and fortune to the study and advancement of science and Christianity. At his sister's Pall Mall address in London where he lived much of his adult life, he performed countless experiments, received visitors and colleagues, and wrote many books. *The Sceptical Chymist* was Boyle's fourth volume, following a devotional treatise, a collection of chemical essays and an

The Sceptical Chymist
ROBERT BOYLE
First published 1661.

Hooke, led to the enunciation of the inverse relationship between the pressure and volume of gases, later named Boyle's law.

The Sceptical Chymist is not an easy read. Begun as a dialogue among proponents of various chemical systems, the book is an unpolished pastiche of several unfinished works. It is prolix, repetitive, disjointed and occasionally contradictory.

Boyle's goals were to question some commonly held chemical theories, to make chemical practitioners more "philosophical" and less commercially focused, and to

account of experiments performed with the 'Pneumatick Engine', or air-pump. That device, built for him by Robert

raise chemistry's status. In his day, the field was held in low esteem; it had no place at universities, its practice was dirty, smelly and laborious. Chemical techniques were used mainly to produce medicaments, a situation preserved in the British usage of the word chemist to mean pharmacist. Chemical textbooks were predominantly lists of pharmaceutical preparations. Boyle believed that chemistry should be much more. For him, it was the key to understanding nature.

Boyle held that chemical pharmacists and textbook writers — the vulgar chymists as he called them — relied on unsound ideas. Chief among them was the concept, advanced by the sixteenth-century medical reformer Paracelsus, that all substances were composed of three essential components. Paracelsians based this belief on their finding that organic materials could be distilled to provide volatile, inflammable and saline fractions, which they named Mercury, Sulphur and Salt, respectively. Boyle argued that these could not be isolated from all materials, and were produced rather than separated by the distilling fire. Hence, they could not be universal principles. Moreover, when the vulgar chymists thought they were concentrating the 'essence' of something by distillation, they were reducing its therapeutic value through thermal decomposition.

Boyle drew on a long chemical tradition for his arguments. A generation earlier, Joan Baptista van Helmont, one of the most influential chemists of the seventeenth century, had expressed the same sceptical views about fire analysis and the three principles. Indeed, contemporaneous readers viewed *The Sceptical Chymist* as a popularization of van Helmont, who proposed that all substances were produced by modification of a single primordial principle — water. Boyle likewise attributed everything to a single stuff, which he called Catholick matter. Differences in the shape, size and motions of minute particles of this matter gave rise to the diverse substances of the world, and changing these characteristics using chemistry could transform any material into any other one. So rather than defining chemical elements as we know them, Boyle doubted that there were any. His view, moreover, supported the alchemists' goal of transmuting base metals into gold.

Although misrepresented by later generations as magical or fraudulent, alchemy was in Boyle's day a serious means of investigating nature. Alchemy had an important and positive role in the history of science. Boyle first learned chemical ideas and practices (and studied van Helmont) under the tutelage of George Starkey, an immigrant from America and graduate of Harvard College. Using the pen-name Eirenaeus Philalethes, Starkey wrote influential books on transmutation and devised a sophisticated theory of matter. Boyle himself strove to prepare the philosophers' stone, the secret substance



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able to transmute metals; he recounted how he had witnessed a demonstration of its powers and tested the gold it produced. He even petitioned Parliament successfully in 1689 to repeal a law forbidding gold-making, which he thought impeded research towards discovering the secret of the stone.

Far from repudiating alchemy, *The Sceptical Chymist* cites alchemical texts and theories to criticize the vulgar chymists. In the 1680 second edition, Boyle referred respectfully to “a much higher order” of chemists “able to transmute baser Metals” and do things that less-skilled chemists “have judg’d impossible”. Although Boyle expressed frustration at the secrecy of alchemical authors, he also thought of them as preferable to and possessed of greater knowledge and expertise than the “meer operators” against whose “unphilosophical” practice his book was directed.

The Sceptical Chymist was neither the most widely read nor the most important of Boyle’s works. Its fame was thrust upon it by retro-

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spective attempts more than two centuries after its publication to locate a revolutionary moment for chemistry. This view attributed to Boyle innovations that later generations thought were important — such as the definition of an element and the repudiation of alchemy — but which were far from Boyle’s mind. Those attempts worked only because few cared to wade through Boyle’s prose and still fewer took time to recognize his motives. Besides, such revolutionary moments exist mostly in the minds of those who imagine that science develops by sudden leaps made by isolated geniuses rather than by slow, laborious steps accumulated and shared by many talented workers.

The Sceptical Chymist was one facet of Boyle’s larger project to elevate the status of chemistry, to free it from servitude to medical and commercial endeavours, and to use it for exploring and explaining the hidden workings of nature. Today, chemistry continues to serve the basic physical needs of society and the intellectual and methodological needs of other sciences more than any other discipline. Even as it continues to struggle with its identity in the ever-changing landscape of modern science, chemistry has become established as an independent, fundamental and philosophical discipline. Boyle, although sceptical of elements and convinced of alchemy, played a key part in this achievement. ■

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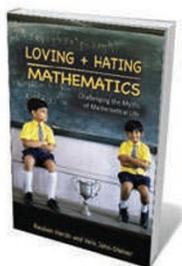
Books in brief



Atoms and Alchemy: Chymistry and the Experimental Origins of the Scientific Revolution

William R. Newman UNIVERSITY OF CHICAGO PRESS 235 pp. \$36 (2011)

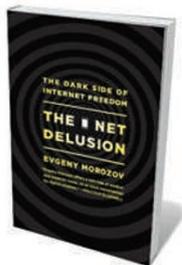
The alchemical roots of chemistry are laid bare by historian of science William Newman. Countering the view that these medieval practices were unscientific, he argues that alchemists seeded ideas such as the particulate nature of matter, the mechanical view of the Universe and the concept of the elements. By discussing how seventeenth-century chemist Robert Boyle was influenced by his predecessors, Newman demonstrates how alchemy helped rather than hindered the emergence of modern science.



Loving and Hating Mathematics: Challenging the Myths of Mathematical Life

Reuben Hersh and Vera John-Steiner PRINCETON UNIVERSITY PRESS 428 pp. \$29.95 (2011)

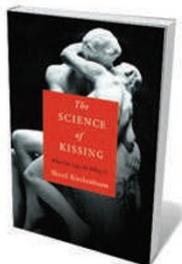
Mathematics gets a bad press. Its practitioners are often portrayed as aloof hyper-rationalists with oodles of logic but no emotional intelligence. Not so, say mathematician Reuben Hersh and linguist Vera John-Steiner. Focusing on the emotional side of the discipline, they reveal mathematicians’ passions, collaborations and love affairs. The stories range from those who sought solace in equations to some who were driven to murder by a maths obsession.



The Net Delusion: The Dark Side of Internet Freedom

Evgeny Morozov PUBLICAFFAIRS 432 pp. \$27.95 (2011)

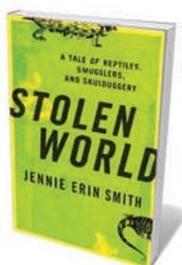
The Internet is often said to be synonymous with democracy and freedom. But there is a dark side, cautions journalist Evgeny Morozov. Rather than liberating citizens worldwide from oppressive rule, digital technology can be just as powerful in suppressing free speech, enabling surveillance and in pacifying populations through immersive entertainment. He calls for an end to glib assumptions that the Internet is inherently good, and for increased efforts towards digital diplomacy, which he says needs as much oversight and consideration as any other kind.



The Science of Kissing: What Our Lips Are Telling Us

Sheril Kirshenbaum GRAND CENTRAL PUBLISHING 272 pp. \$19.99 (2011)

We really do remember our first kiss, explains science writer Sheril Kirshenbaum in her palatable book about why we pucker up. Weaving together evolutionary biology, psychology and anthropology, she describes how different cultures do it differently, and reveals how we sense the fitness of our kissing partner while enjoying the neurological hit of close sensory contact. She explains how men and women kiss differently and why kissing disappeared during the Dark Ages.



Stolen World: A Tale of Reptiles, Smugglers, and Skulduggery

Jennie Erin Smith CROWN 336 pp. \$25 (2011)

The alien appeal of alligators, snakes and lizards leads enthusiasts to scour the world for rare reptile species. Some collectors will go to great lengths to get them, resulting in a multimillion-dollar black market in illegally imported animals. Through interviews with knife-wielding reptile dealers, science reporter Jennie Smith uncovers this bizarre underworld. She finds that not even zookeepers are exempt from pushing the limits of morality to obtain an unusual breed.