

**Maxwell's famous differential equations unify the laws of electricity, magnetism, and light.**

Maxwell, James Clerk. *A treatise on electricity and magnetism*. Oxford: Clarendon Press, 1873. Clarendon Press Series. 9 1/16 inches (230 mm), 2 vols. (xxix, 423 pp.; xxiii, 444 pp.), [20] leaves of plates.

James Clerk Maxwell (1831–79) was the greatest theoretical physicist of the 19th century, eminent alike in the fields of statistical mechanics, electromagnetism, thermodynamics, the kinetic theory of gases, geometrical optics, elasticity, and cybernetics. He would surely have approved of the appearance of his *Treatise on Electricity and Magnetism* on this website, for Maxwell's historical spirit was strong. As he once wrote:

It is of great advantage to the student of any subject to read in the original memoirs on that subject, for science is always most completely assimilated when it is found in its nascent state. Every student of science should, in fact, be an antiquary in his subject.

Indeed, by Maxwell's admission, his book is not so much a treatise on his own electromagnetic theory as presented in five major papers (1855–68), as an historical and experimental exposition of the state of mind of a physicist who had published such papers. As he put it in a later conversation reported by Sir Joseph Larmor, his purpose was not to expound his theory finally to the world but to educate himself by presenting a view of the stage he had reached. No one has ever called it a systematic treatise. It is a workshop of ideas, presented with an oracular discursiveness often found in Maxwell's private letters (apart from Augustus De Morgan's, the most vivacious of any British scientist).

The *Treatise* is thus a sort of polyphonic conversation, in which (at any given moment) some statements are made more insistently, or certain arguments presented in a more developed form, or a new approach or attack is suddenly to be made from scratch. Maxwell, astonishingly, insisted that its four parts—on Electrostatics, Electrokinetics, Magnetism, and Electricity—should be read *concurrently*. Similarly conversational are

the many minor errors in sign or numerical value scattered through the book, a failing more acceptable in impromptu table-talk than on the printed page. As G.R. Kirchhoff said of Maxwell, “He is a genius but one must check his calculations before one can accept them.” The almost offhand presentation of Maxwell’s famous differential equations is like a voice heard throughout the room during a lull in a party: they are hidden away in a corner toward the end of the last book (Book 4, Chapter 9—see **Spreads 128–34**) where they are applied brilliantly to the electromagnetic theory of light (Book 4, Chapter 20—see **Spreads 206–14**). These four were adapted and codified by Maxwell from Faraday’s Law on electromotive force, Coulomb’s Law on the electrical charge, and Ampère’s Law, as modified to account for the magnetic field produced by a changing electric field (through what Maxwell called a “displacement current”)—to which was added the determination that magnetic charges do not, in fact, exist. Together the four equations unified the laws of electricity, magnetism, and light: they combine to describe every aspect of our modern high-tech electromagnetic world.

The style of presentation, in a series of brief numbered paragraphs, may remind a later reader of the philosophic habits of Wittgenstein or Collingwood, but to Maxwell it must surely have seemed to echo Biblical chapter and verse. It was inconceivable for so pious a Scot of his generation, however humorous and poetical, not to be influenced by religious rhetoric. (Many of Maxwell’s letters to his wife—they had no children—are miniature sermons.) Just as clergymen liked to refer to God as speaking through his Priests and Prophets, Maxwell wrote of Physics as though it were speaking through the voice of Electricity.

It is impossible, even today, to study physics and escape the shadow of Maxwell, so numerous and important are the equations and theory associated with his name—impossible, too, not to echo his words. The opening sentence of the *Treatise* is: “The fact that certain bodies, after being rubbed, appear to attract other bodies, was known to the ancients ...” The standard modern textbook, *Classical Electrodynamics*, begins: “Although amber and lodestone were known to the ancient Greeks...” A good graduate student is expected to recognize the allusion: one cannot improve upon a classic.