

## The four Maxwell equations

	Partial differential form	Integral form
Gauss's law:	$\nabla \cdot \mathbf{D} = \rho$	$\oint_A \mathbf{D} \cdot d\mathbf{A} = \frac{Q_{encl}}{\epsilon_0}$
Gauss's law for magnetism:	$\nabla \cdot \mathbf{B} = 0$	$\oint_A \mathbf{B} \cdot d\mathbf{A} = 0$
Faraday's law of induction:	$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$	$\oint_S \mathbf{E} \cdot d\mathbf{s} = -\frac{d\Phi_B}{dt}$
Ampere's law + Maxwell's extension:	$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$	$\oint_S \mathbf{H} \cdot d\mathbf{s} = \mu_0 I_{enc} + \frac{d\Phi_D}{dt}$

- $\rho$  is the *free* electric charge density (in units of C/m<sup>3</sup>), not including dipole charges bound in a material,
- $\mathbf{B}$  is the magnetic flux density (in units of tesla, T), also called the magnetic induction,
- $\mathbf{D}$  is the electric displacement field (in units of C/m<sup>2</sup>),
- $\mathbf{E}$  is the electric field (in units of V/m),
- $\mathbf{H}$  is the magnetic field strength (in units of A/m),
- $\mathbf{J}$  is the current density,
- $\nabla \cdot$  is the divergence operator,
- $\nabla \times$  is the curl operator,
- $\Phi_B$  is the magnetic flux through an area and
- $\Phi_D$  is the electric flux through an area.

Maxwell's equations are the set of four equations by James MAXWELL (1831 - 1879) that describe the behaviour of both the electric and magnetic fields. Maxwell's equations provided the basis for the unification of electric field and magnetic field, the electromagnetic description of light, and ultimately, Albert Einstein's theory of relativity. The elegant modern mathematical formulations of Maxwell's equations were not developed by Maxwell. In 1884, Oliver Heaviside reformulated Maxwell's equations using vector calculus. This change reinforced the perception of physical symmetries between the various fields with a more symmetric mathematical representation.

The electromagnetic field equations have an intimate link with special relativity: the magnetic field equations can be derived from consideration of the transformation of the electric field equations under relativistic transformations at low velocities.

More information about the Maxwell equations can be found under:

- [http://www.rare-earth-magnets.com/magnet\\_university/maxwells\\_equations.htm](http://www.rare-earth-magnets.com/magnet_university/maxwells_equations.htm)
- [http://www.tf.uni-kiel.de/matwis/amat/semi\\_en/kap\\_2/basics/b2\\_2\\_2.html](http://www.tf.uni-kiel.de/matwis/amat/semi_en/kap_2/basics/b2_2_2.html)
- <http://encyclopedia.thefreedictionary.com/Maxwell's%20equations>
- <http://cnet.dyndns.org/engineering/emag2/node2.html>
- [http://en.wikipedia.org/wiki/Maxwell%27s\\_equations](http://en.wikipedia.org/wiki/Maxwell%27s_equations)

**James Clerk Maxwell** (June 13, 1831 – Nov. 5, 1879)

was a Scottish physicist, born in Edinburgh. In 1847, Maxwell attended Edinburgh University studying natural philosophy, moral philosophy, and mental philosophy.

In 1860, he was a professor at King's College in London. In 1861, Maxwell was elected to the Royal Society.

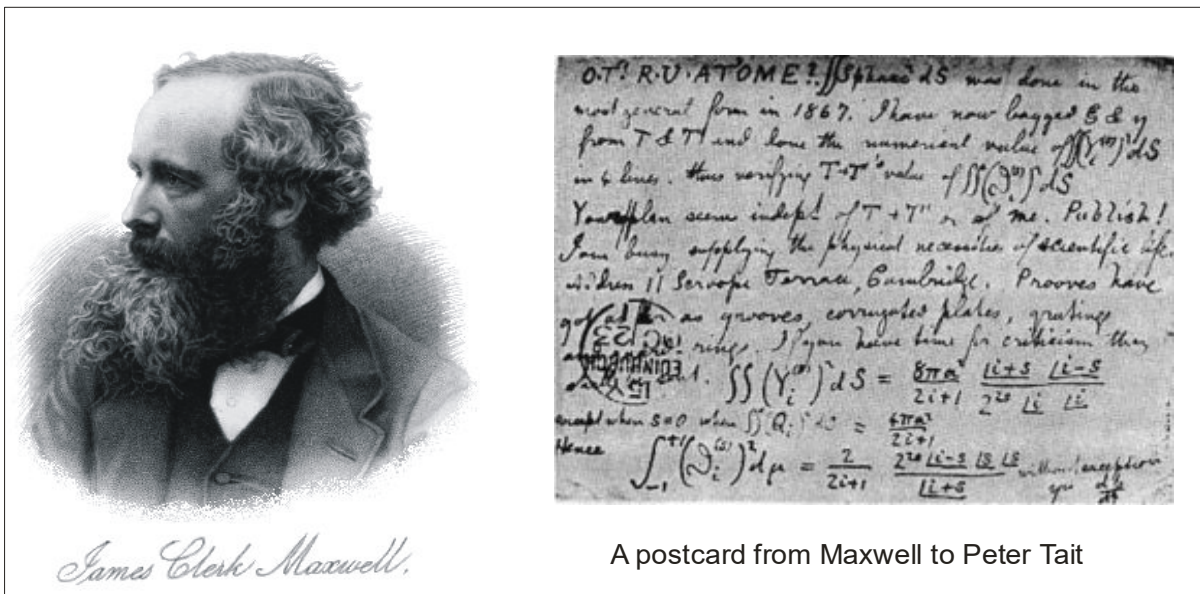
Maxwell researched elastic solids and pure geometry during this time, also. The great work of Maxwell's life was devoted to electricity. Maxwell's most important contribution was the extension and mathematical formulation of earlier work on electricity and magnetism by Michael Faraday, André-Marie Ampère, and others into a linked set of differential equations in quaternions (originally, 20 equations in 20 variables).

Between 1864 and 1873, Maxwell conducted research and demonstrated that the equations could express the behavior of electromagnetic fields and their interrelated nature.

In 1931, on the centennial anniversary of Maxwell's birth, Einstein described Maxwell's work as the **"most profound and the most fruitful that physics has experienced since the time of Newton."**

In 1871, he was the first Cavendish Professor of Physics at Cambridge. Maxwell supervised the development of the Cavendish laboratory. He superintended every step of the progress of the building and of the purchase of the very valuable collection of apparatus with which it was equipped at the expense of its generous founder, the seventh duke of Devonshire (chancellor of the university, and one of its most distinguished alumni). One of Maxwell's last great contributions to science was the editing (with copious original notes) of the Electrical Researches of Henry Cavendish, from which it appeared that Cavendish researched such questions as the mean density of the earth and the composition of water, among other things.

Maxwell married, but fathered no children. On November 5, 1879, he died in Cambridge of abdominal cancer. He was 48.



Source:

[http://en.wikipedia.org/wiki/James\\_Clerk\\_Maxwell](http://en.wikipedia.org/wiki/James_Clerk_Maxwell)