

UNL2206, Nature's Threads: Short Essay Assignment

Reproduced below is an extract from J.C. Maxwell's *Treatise on Electricity and Magnetism*:

“ ... before I began the study of electricity I resolved to read no mathematics on the subject till I had first read through Faraday's *Experimental Researches in Electricity*. I was aware that there was supposed to be a difference between Faraday's way of conceiving phenomena and that of the mathematicians, so that neither he nor they were satisfied with each other's language. I had also the conviction that this discrepancy did not arise from either party being wrong. I was first convinced of this by Sir William Thomson, to whose advice and assistance, as well as to his published papers, I owe most of what I have learned on the subject.

As I proceeded with the study of Faraday, I perceived that his method of conceiving the phenomena was also a mathematical one, though not exhibited in the conventional form of mathematical symbols. I also found that these methods were capable of being expressed in the ordinary mathematical forms, and thus compared with those of the professed mathematicians.

For instance, Faraday, in his mind's eye, saw lines of force traversing all space where the mathematicians saw centres of force attracting at a distance: Faraday saw a medium where they saw nothing but distance: Faraday sought the seat of the phenomena in real actions going on in the medium, they were satisfied that they had found it in a power of action at a distance impressed on the electric fluids.

When I had translated what I considered to be Faraday's ideas into a mathematical form, I found that in general the results of the two methods coincided, so that the same phenomena were accounted for, and the same laws of action deduced by both methods, but that Faraday's methods resembled those in which we begin with the whole and arrive at the parts by analysis, while the ordinary mathematical methods were founding on the principle of beginning with the parts and building up the whole by synthesis.

I also found that several of the most fertile methods of research discovered by the mathematicians could be expressed much better in terms of ideas derived from Faraday than in their original form.

... I have confined myself almost entirely to the mathematical treatment of the subject, but I would recommend the student, after he has learned, experimentally if possible, what are the phenomena to be observed, to read carefully Faraday's *Experimental Researches in Electricity*. He will there find a strictly contemporary historical account of some of the greatest electrical discoveries and investigations, carried on in an order and succession which could hardly have been improved if the results had been known from the first, and expressed in the language of a man who devoted much of his attention to the methods of accurately describing scientific operations and their results.

It is of great advantage to the student of any subject to read the original memoirs on that subject, for science is always most completely assimilated when it is in the nascent state, and in the case of Faraday's *Researches* this is comparatively easy, as they are published in a separate form, and may be read consecutively. If by anything I have here written I may assist any student in understanding Faraday's modes of thought and expression, I shall regard it as the accomplishment of one of my principal aims — to communicate to others the same delight which I have found myself in reading Faraday's *Researches*. ”

Write a short essay on the ideas underlying Faraday's “lines of force” and how it influenced Maxwell, eventually leading to the latter's development of the theory of the electromagnetic field. Your essay should include an account of Faraday's ideas and an examination of the impact these had on Maxwell. It should also include some discussion of the sequence of models for electricity and magnetism developed by Maxwell. The essay should conclude with *a critical evaluation* of the extent to which Faraday's ideas informed Maxwell's work, as well as where their respective ideas on forces and fields diverged.

Your essay should be between three and a maximum of four single spaced A4 pages, with references (including page numbers) cited as footnotes. This assignment is **due in at the end of Week 8.**

Apart from original sources (Faraday and Maxwell themselves), you may wish to consult the following (the book by Simpson is available in the reading room) or any other sources that you consider relevant or useful:

Maxwell on the Electromagnetic Field: A Guided Study

by Thomas K. Simpson

Fields of force: the development of a world view from Faraday to Einstein

by William Berkson, on-line version available at:

http://books.google.com/books/about/Fields_of_force.html?id=hMc9AAAAIAAJ

Innovation in Maxwell's Electromagnetic Theory: Molecular Vortices, Displacement Current and Light

by D.M.Siegel, on-line version available at:

http://books.google.com.sg/books?id=AbQq85U8K0gC&printsec=frontcover&dq=Siegel%2BMaxwell&hl=en&redirect_esc=y#v=onepage&q=Siegel%2BMaxwell&f=false