

**CLARENDON PRESS SERIES. AN
INTRODUCTION TO THE
MATHEMATICAL THEORY OF
ELECTRICITY AND MAGNETISM**

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Clarendon Press Series. An Introduction to the Mathematical Theory of Electricity and Magnetism by W. T. A. Emtage

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W. T. A. EMTAGE

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EMTAGE

Clarendon Press Series

Alexander Zivex 07

An Introduction to the
Mathematical Theory of Electricity
and Magnetism

BY
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Examiner in the School of Natural Science, Oxford

Oxford

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1891

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PREFACE.

THIS book has been written with the object of supplying an Introduction to the Mathematical treatment of Electricity and Magnetism, and will, it is hoped, be useful to those who possess the requisite elementary knowledge of Differential and Integral Calculus. It is complete in itself, and may be read without previous knowledge of the subject. Purely experimental parts of the subject, requiring no special mathematical treatment, have been entirely omitted.

The Author is especially indebted for assistance to the Treatises of Professor Clerk Maxwell, and of Messrs. Mascart and Joubert.

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AN INTRODUCTION TO
THE MATHEMATICAL THEORY
OF ELECTRICITY.

PART I.

CHAPTER I.

LAWS OF ELECTRICAL ACTION. POTENTIAL.

1. **ELECTRIFICATION.** If a carefully dried glass rod is held in the hand and rubbed with a piece of dry silk, it is found to acquire the property of being able to attract light bodies, such as little pieces of paper or straw, pith balls, &c. Several other bodies show the same property, as, for instance, a rod of ebonite rubbed with flannel or a cat's skin.

Bodies which possess this property are said to be *electrified*, or *electrically excited*, or to be charged with *Electricity*.

Among bodies which show electrical excitement well in this way, may be mentioned, besides glass and ebonite, amber, sulphur, resin, and sealing-wax.

2. With certain bodies this experiment is impossible, as, for instance, with a rod of brass or any other metal. Electricity is developed on the surface of the metal, as it is on the rod of glass, but it immediately flows away through the hand and body to the earth. But if the metal rod be provided with a handle made of glass it will retain its electrical charge just as the glass rod did.

We must then distinguish between two classes of bodies:—

(i) Those which allow electrical charges readily to pass through them, or over their surfaces. These bodies are called *conductors*.

(ii) Those which offer good resistance to the passage of electrical charges, and retain them for a long time. These bodies are called *non-conductors*, or *insulators*.

No sharp line can be drawn between these two classes, as bodies possess all shades of conducting and insulating power. Also there exists no perfect conductor, and no perfect insulator. Every body conducts electricity, or allows it to pass, with more or less freedom; and the best-known conductor offers a certain amount of resistance to the passage.

3. Two kinds of Electrification. If we take two glass rods and rub them with a piece of silk, they will be found to exert a force of repulsion on each other. But a glass rod rubbed with silk and an ebonite rod rubbed with flannel are found to attract each other. A gilt pith ball suspended by a piece of silk and touched with the glass rod is found to be repelled by the glass, but attracted by the ebonite rod.

From these experiments we infer that there are two kinds of electricity. Now the glass rods were obviously charged alike, and on touching the pith ball with one of them it gave to it a part of its own charge. All these charges repel each other. The electrified ebonite rod behaves in a different way; it attracts any of these bodies. Thus we see that the ebonite rod is charged with a different kind of electricity. And we would further see that the ebonite rod would repel a similarly electrified ebonite rod, or a pith bar suspended by silk which had been touched by it.

We thus infer the existence of two kinds of electricity, and the mutual actions of bodies charged with them. This action may be stated in the following law of electrical action.

LAW I. Bodies charged with like electrical charges repel each other; bodies charged with unlike electrical charges attract each other.

These two sorts of electricity are called positive and negative