ELEMENTARY ELECTRICITY AND MAGNETISM: A TEXT-BOOK FOR COLLEGES AND TECHNICAL SCHOOLS

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WM. S. FRANKLIN & BARRY MACNUTT

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BY

WM. S. FRANKLIN AND BARRY MACNUTT

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PREFACE AND INTRODUCTION

"Alles Vergängliche ist nur ein Gleichniss."
(Intelligibility is only likeness.) — !?!

The study of electricity and magnetism as represented in the following chapters is independent of any consideration of the nature of the physical action which leads to the production of electromotive force in a voltaic cell or dynamo; it is independeut of any consideration of the nature of the physical action which constitutes an electric current in a wire; it is independent of any consideration of the nature of the disturbance which constitutes a magnetic field; and it is independent of any consideration of the nature of the disturbance or stress which constitutes an electric field. This kind of study of electricity and magnetism may very properly be called *electro-mechanics*.

Simple mechanics is the study of ordinary bodies at rest or in visible motion, and one of the most important ideas in mechanics is the idea of force, but the science of mechanics is not concerned with, and indeed it sheds no light upon, the question as to the physical nature of force. Thus, the science of mechanics is not concerned with the question as to the nature of the action which takes place in a gas and causes the gas to exert a force on a piston; the science of mechanics is not concerned with the question as to the nature of the action which takes place in the material of a stretched wire causing the wire to exert a pull upon each of the two supports at its ends; the science of mechanics is not concerned with the nature of the action between the earth and a heavy weight which causes the earth to exert a force on the weight. It is sufficient for the science of mechanics that these things are what may be called *states of permanency* which involve certain invariant co-relations. Thus, in the case of a stretched wire there is a certain invariant relation between what we call the

value of the stretching force and the amount of elongation, in the case of a gas there is a certain invariant relation between the density of the gas and its pressure, and so on.*

Similarly it is sufficient for the science of electro-mechanics that such things as electric current, electromotive force, magnetic field and electric field are *states of permanency* which involve invariant co-relations.

The character of the science of mechanics and of the science of electro-mechanics may be further exemplified as follows: A sample of steel under test is broken by a tension of 120,000 pounds, but the exact character of the action which takes place in the steel when it is placed under tension is not a matter for consideration. Neither does one need to consider the action which takes place in the furnace of the boiler which supplies steam to the engine which drives the dynamo which supplies current to the motor which drives the testing machine! A plate of glass under test is broken down and punctured by an electromotive force of 95,000 volts, but the exact character of the action which takes place in the glass when it is subjected to the electromotive force is not a matter for consideration. Mechanics is concerned with the correlation of what may be called lump effects, such as the relationship between the size of a beam and the load it can carry, the size of a fly wheel and the work it can do when stopped, the thickness and diameter of a boiler shell and the pressure it can stand, the size of a submerged body and the buoyant force which acts upon it, the size and shape of the air column in an organ pipe and its number of vibrations per second, the thickness of a glass plate and the electromotive force it can stand, the size of a copper wire and the current it can carry with a given rise of temperature and so forth.

Another important method in physics is the so-called *atomistic*

* This statement does not distinguish between mechanics in a narrow sense and what is called thermodynamics, which is the study of changes of state; including the subject of heat and the whole of chemistry. See Franklin and MacNutt's *Mechanics and Heat*, pages 273–279, for a full discussion of this matter.

*method.** This method is extensively used in the elementary study of heat and in elementary chemistry, and it is a tremendously powerful help to research in nearly every branch of physics and chemistry. We believe, however, that it is a mistake to set forth the hypotheses of the atomic theory in an elementary treatise on electricity and magnetism.

Following the plan of our *Mechanics and Heat*, we wish to include an introduction to this text, but what needs to be said in introduction is very brief, assuming that the student has read the introduction to our Mechanics and Heat. If there is a widespread indifference towards rational physics study on the part of young men (and many of our teachers seem to think there is), it can be overcome, we believe, by leading young men to understand what **KIND** of interest they can be expected to have in such study. Gilbert Chesterton says, very wisely, that the only spiritual or philosophical objection to steam engines is not that men pay for them, or work at them or make them very ugly, or even that men are killed by them; but merely that men do not play at them. This is precisely the objection to physical science; men do not play at it.

THE AUTHORS.

April 22, 1914.

* The essential features of the atomistic method are set forth in a simple and intelligible way on pages 274–275 of Franklin and MacNutt's *Mechanics and Heat*.

A third method in physics, one which is only beginning to be recognized, is the *statistical method*, which is described on pages 350–352 of Franklin and MacNutt's *Mechanics and Heat*.

One must not think that the atomic theory of gases (the so-called kinetic theory), for example, is a branch of mechanics *merely because the fundamental ideas are mechanical ideas*. The classification of methods in physical science is properly based on a consideration of kinds of observation and the way in which accompanying theory is brought to bear upon the methods and results of observation.

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