ELEMENTARY TREATISE ON NATURAL PHILOSOPHY; IN FOUR PARTS; PART 1: MECHANICS, HIDROSTATICS, AND PNEUMATICS

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A. PRIVAT DESCHANEL

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Trieste

ELEMENTARY TREATISE

ON

NATURAL PHILOSOPHY.

BY

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TRANSLATED AND EDITED, WITH EXTENSIVE MODIFICATIONS,

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IN FOUR PARTS.

PART I.

MECHANICS, HYDROSTATICS, AND PNEUMATICS,

ILLUSTRATED BY

180 ENGRAVINGS ON WOOD, AND ONE COLORED PLATE.

NEW YORK:
D. APPLETON AND COMPANY,
1, 3, AND 5 BOND STREET.
1883.

AUTHOR'S PREFACE.

THE importance of the study of Physics is now generally acknowledged. Besides the interest of curiosity which attaches to the observation of nature, the experimental method furnishes one of the most salutary exercises for the mind—constituting in this respect a fitting supplement to the study of the mathematical sciences. The method of deduction employed in these latter, while eminently adapted to form the habit of strict reasoning, scarcely affords any exercise for the critical faculty which plays so important a part in the physical sciences. In Physics we are called upon, not to deduce rigorous consequences from an absolute principle, but to ascend from the particular consequences which alone are known to the general principle from which they flow. In this operation there is no absolutely certain method of procedure, and even relative certainty can only be attained by a discussion which calls into profitable exercise all the faculties of the mind.

Be this as it may, physical science has now taken an important place in education, and plays a prominent part in the examinations for the different university degrees. The present treatise is intended for the assistance of young men preparing for these degrees; but I trust that it may also be read with profit by those persons who, merely for purposes of self-instruction, wish to acquire accurate knowledge of natural phenomena. Having for nearly twenty years been charged with the duty of teaching from the chair of Physics in one of the lyceums of Paris, I have been under the necessity of making continual efforts to overcome the inherent difficulties of this branch of study. I have endeavoured to turn to account the experience thus acquired in the preparation of this volume, and I shall be happy if I can thus contribute to advance the taste for a science which is at once useful and interesting.

I have made very limited use of algebra. Though calculation is a precious and often indispensable auxiliary of physical science, the extent to which it can be advantageously employed varies greatly according to circumstances. There are in fact some phenomena which cannot be really understood without having recourse to measurement; but in a multitude of cases the explanation of phenomena can be rendered evident without resorting to numerical expression.

The physical sciences have of late years received very extensive developments. Facts have been multiplied indefinitely, and even theories have undergone great modifications. Hence arises considerable difficulty in selecting the most essential points and those which best represent the present state of science. I have done my best to cope with this difficulty, and I trust that the reader who attentively peruses my work, will be able to form a pretty accurate idea of the present position of physical science.

TRANSLATOR'S PREFACE

TO THE SIXTH EDITION.

I DID not consent to undertake the labour of translating and editing the "TRAITÉ ÉLÉMENTAIRE DE PHYSIQUE" of Professor Deschanel until a careful examination had convinced me that it was better adapted to the requirements of my own class of Experimental Physics than any other work with which I was acquainted; and in executing the translation I steadily kept this use in view, believing that I was thus adopting the surest means of meeting the wants of teachers generally.

In the original English edition, the earlier portions consisted of a pretty close translation from the French; but as the work progressed I found the advantage of introducing more considerable modifications; and Parts III. and IV. were to a great extent rewritten rather than translated. I have now, in like manner, rewritten Part I., and trust that in its amended form it will be found better adapted than before to the wants of English teachers. Several additional subjects have been introduced, and the order of the chapters has been rearranged.

The marks of distinction which were made in the earlier editions between new and old sections have now been dropped; but Professor Deschanel's foot-notes are still distinguished by the initial "D." The numbering of the sections is entirely new.

All accurate statements of quantities have been given in the C.G.S. (Centimetre-Gramme-Second) system, which, by reason of its simplicity and of the sanction which it has received from the British Association, and the Physical Society of London, is coming every day into more general use, but rough statements of quantity have generally been expressed in British units as being more familiar. A complete table for the conversion of French and English measures will be found at the end of the Table of Contents.

In Part II., the subject of Heat as a measurable Quantity is introduced at a much earlier stage than before, the chapter on Calorimetry being placed immediately after those on Thermometry and Expansion. Latent Heat and Heat of Combination are not now included in this chapter, but are treated later in connection with the subjects of Fusion, Vaporization, and Thermo-dynamics.

Among the new matter may be mentioned:—

An investigation of the temperature of minimum apparent volume of water in a glass envelope;
An account of Guthrie's results on the freezing of brine;
A proof that the pressure of vapour in the air at any time is equal to the maximum pressure for the dew-point;
Descriptions of Dines' hygrometer, and of Symons' Snowdon rain-gauge;
A full explanation of "Diffusivity" or "Thermometric Conductivity;"
Some recent results on the conductivity of rocks, and on the conductivity of water;
A note on the mathematical discussion of periodical variations of underground temperature;
A proof of the formula for the efficiency of a perfect thermo-dynamic engine;
Several investigations relating to the two specific heats of a gas, and to adiabatic changes in gases, liquids, and solids;
A description of the modern Gas Engine.

Every chapter has been carefully revised, with a view to clearness, accuracy, and consolidation; and the result has been that, with the exception of Melloni's experiments, and the Steam Engine, the treatment of nearly every subject has been materially changed.

Part III. also contains extensive changes.

In the electro-statics, the chapter on potential has been recast and made more demonstrative. There are also additions relating to Dr. Kerr's discoveries, charge by cascade, and some minor points.

Under the head of Magnetism, investigations have been introduced relating to bifilar suspension, and to the directive tendency of soft-iron needles.

In the department of Current Electricity, there has been a complete rearrangement of subjects. The chemical relations of the current are discussed as early as possible, while thermo-electricity is reserved for a chapter on relations between electricity and heat. The chapter on induced currents, which was formerly the last of all, has been put next to that on electro-dynamics, and is followed by two chapters on telegraphs and other applications of electricity. Additional matter has been introduced under the following heads:—

General law for magnetic force due to current in given circuit;
Helmholtz's galvanometer;
Swing produced by instantaneous current;
The galvanometer a true measurer of current;
Rowland's experiment on the motion of a charged body;
Planté's secondary battery;
Chemical relations of electro-motive force;
Resistance coils and boxes;
Wheatstone's bridge, and conjugate branches;

Clark's method for electro-motive force;
Thomson's method for resistance of galvanometer;
Mance's method for resistance of battery;
Thermo-electric diagrams;
Convection of heat by electricity;
Pyro-electricity;
Effect of light on resistance of selenium;
Deduction of law of induced currents from electro-dynamic law;
Superposition of tubes of force;
Stratified discharge from galvanic battery;
Siemens' and Gramme's magneto-electric machines;
Cowper's writing telegraph;
Duplex telegraphy;
Edison's electric pen;
The telephone, the microphone, and the induction balance.

A collection of examples on electricity has been added.

Part IV. contains no radical changes. The numbering of the chapters and sections has been altered to make it consecutive with the other three Parts, but there has been no rearrangement.

Additions have been made under the following heads (those marked with an asterisk were introduced in a previous edition):—

Mathematical note on stationary undulation;
Edison's phonograph;
Michelson's measurement of the velocity of light;
Astronomical refraction;
*Refraction at a spherical surface;
Refraction through a sphere;
Brightness of image on screen;
Field of view in telescope;
*Curved rays of sound;
*Retardation-gratings and reflection-gratings;
Kerr's magneto-optic discoveries;

besides briefer additions and emendations which it would be tedious to enumerate.

The whole volume has been minutely revised; and a copious collection of examples arranged in order, with answers, has been introduced at the end of each Part, in place of the "Problems" (translated from the French) which appeared in some of the earlier editions.

The dates of revision of the four Parts were, October, 1879, November, 1880, December, 1880, and May, 1881.

J. D. E.

BELFAST, *September, 1881.*

CONTENTS—PART I.

(THE NUMBERS REFER TO THE SECTIONS.)