ELEMENTS OF VECTOR ALGEBRA

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WITH DIAGRAMS

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PREFACE

THIS little book was written at the instance of Messrs. Adam Hilger, and, in accordance with their desire, it contains just what is required for the purpose of reading and handling my *Simplified Method of Tracing Rays, etc.* (Longmans, Green & Co., London, 1918). With this practical aim in view, all critical subtleties have been purposely avoided. In fact, it is scarcely more than a synoptical presentation of the elements of Vector Algebra covering the needs of those engaged in geometrical optics. At the same time, however, it is hoped that this booklet will serve a more general purpose, viz. to provide everybody unacquainted with the subject with an easy introduction to the use of Vector Algebra.

It is scarcely necessary to explain that the deductions given in this book are based on Euclid's axioms, notably with the inclusion of his postulate of parallels—upon which the equality of vectors is most essentially based. Those readers who are desirous of seeing how the formal rules here given can be generalized so as to be valid independently of the axioms of congruence and of parallels, may consult the author's *Projective Vector Algebra* (Bell & Sons, 1919), and a sequel to it published in *Phil. Mag.* for July, 1919, pp. 115-143. It is, however, advisable for the student to become first thoroughly familiar with the euclidean vector algebra as here presented.

I take the opportunity of expressing my sincere thanks to Messrs. Hilger for enabling me to make this further contribution towards the promotion of the more general use of this powerful and convenient language of vectors, and to the Publishers for the care they have bestowed upon this little book. L. S.

LONDON, *August*, 1919.

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1. Vectors defined. Whereas common algebraic magnitudes, such as the number of inhabitants of a village, or the mass of a body, or the energy stored in an accumulator, having nothing to do with direction, are called *scalars*, any magnitude such as a displacement, a velocity or an acceleration, which has size as well as *direction* in space, is called a *vector*. The visual, or tangible, representative of any vector whatever is a segment of a straight line of some length, representing the vector's size, and of some definite direction in space, together with its *sense* (say, from a point M towards a point N), giving the direction of the vector.

Vectors will be printed in Clarendon, thus

$$\mathbf{A}, \mathbf{B}, \text{etc.,} \quad \text{or} \quad \mathbf{n}, \mathbf{r}, \mathbf{s}, \text{etc.,}$$

and their sizes, regardless of direction, or their *tensors* (as they are called) will be denoted by the same letters in Italics. Thus, A will be the tensor of $\mathbf{A}$; B, n will be the tensors of $\mathbf{B}$, $\mathbf{n}$, and so on.

Returning once more to the above definition, we may as well say that any vector $\mathbf{A} = OE$ is given by the ordered couple or *pair* of points, O the *origin* and E the end-point of the vector; the tensor, called also the absolute value, of the vector being the mutual distance of O and E. In short symbols, and using the familiar bar for the distance,

$$\mathbf{A} = O \rightarrow E, \quad A = \overline{OE}.$$

The tensor of a vector is thus an ordinary, absolute or essentially positive number.

A vector whose tensor is (in a conventionally fixed scale) equal to unity, is termed an *unit vector*. Thus, if $r = 1$, the corresponding $\mathbf{r}$ will be a unit vector. It will be understood that the denomination of A is that of $\mathbf{A}$. That is to say, if $\mathbf{A}$ is, for instance, the