curately determinable than cross-section. Another somewhat serious mistake, since it is fundamental, is the statement on page 18, that specific resistance is 'the resistance of any particular substance as compared with the resistance of a piece of some other conductor, such as silver, both being of unit dimensions.' As a matter of fact, specific resistance, which is a very important term, is the resistance in ohms of a unit volume, and is entirely independent of any particular standard substance. The use of the term 'magnetic resistance,' on pages 219 to 221, is open to objection, since the term 'reluctance' is now almost universally employed to distinguish this quantity from electrical resistance.

Taken as a whole, however, the errors are not numerous, and the work is recommended as a text or reference book for those who desire to learn the principles, general construction and action of the various kinds of electrical machinery and instruments, with the exceptions already noted. F. B. CROCKER.

PHYSIOLOGICAL PHYSICS.

On the Spontaneous Heating and Ignition of Hay. BERTHELOT. Ann. Chim. Phys., 7, 2. p. 430. 1894.

The author finds that poorly dried hay may ignite when the rise in temperature is only to 140° C. (280° Fh.). The evolution of heat necessary for this rise of temperature is due to the absorption of oxygen in spite of the interrupted sprouting, which will only take place when the hay is quite wet. The chemical process involving this absorption of oxygen may continue until the hay is thoroughly dry.

Druck und Arbeitsleistung durch Wachsende Pflanzen. W. PFEFFER. Abh. d. Math.-Phys. Kl. der K. Sachsicher Gesellschaft der Wiss., 20. p. 235. 1893.

Mr. Pfeffer investigated very carefully and ingeniously the pressure exerted by parts of plants in growth, and found, for example, that a root point could exert a pressure of 10–15 atmospheres. He ascribes these forces to osmotic pressure, and criticises the view concerning the growth of the cell-wall, which ascribes it to simple plastic expansion.

La Lumière Physiologique. R. DUBOIS Rev. gén. des Sciences, 5. p. 415 and p. 529. 1894.

Part first contains a review of light emitting organisms, and a description of the organs involved. In part second the author treats the subject of the emission more thoroughly, describing the character of the light radiated, and finds that the brightest Pyrophorus radiates $1,4 \times 10^{-7}$ calorie in ten minutes.

The author summarizes his extensive investigations as follows:

Neither a perfect organ nor a perfect cell is necessary for the coming and going of the light. The cell produces the photogenic substance which, once formed, may light or not, according to the conditions surrounding it.

They must fulfill the conditions necessary for life, must contain oxygen and water, and have a suitable temperature.

The light (luminous energy) is found to be 90% of the total energy radiated.

Dubois made a fluorescent substance from the blood of Pyrophorus, which, like that from the animal itself, lost its peculiar property on being treated with weak acetic acid and regained it on treatment with ammonia.

All the causes which excite or destroy the activity of the protoplasm have a similar effect upon the production of the physiological light.

The production of light depends upon the change of living protoplasmic granulations into the condition of lifeless crystalline matter.

It is to be remembered that the secretions of *Orya barbarica* are acid, thus in this case excluding the explanation of Radziszewski.

WILLIAM HALLOCK.

MATHEMATICS.

*The Principles of Differentiation in Space-Analysis.** By A. MACFARLANE, D. Sc., LL. D.

According to Hamilton the differentiation of a function of a quaternion presents novel difficulties due to the non-commutative character of a product of quaternions. There is in general no derived function, and it is necessary to define the differential in a new manner. Under certain conditions there is an analogue to Taylor's Theorem, but it is very complex, and no use is made of it. Hamilton does not differentiate the general transcendental functions, but only these functions restricted to a constant plane.

The author shows that these anomalies are true of products of vectors, but not of functions of versors. In versor analysis there is a derived function, satisfying a generalized form of Lagrange's definition; and Taylor's Theorem takes on a form similar to that in ordinary analysis, only the order of the two quantities must be preserved. Let x and h denote two versors, then

$$f(x+h)=f(x)+f'(x)h+\tfrac{1}{2}f''(x)h^2+, \text{ etc.},$$

provided the order of the x and h be preserved throughout.

The author finds the derived functions of various transcendental functions in space. He also shows that there are two essentially different meanings of $\sqrt{-1}$; one, when made definite, means a quadrant of rotation round a specified axis; while the other has no reference to direction, but distinguishes the area of a hyperbolic angle from the area of a circular angle. He also remarks that the theory of functions must be imperfect, because it is based upon a complex number which is restricted to one plane; no account is taken of the two essentially different meanings of $\sqrt{-1}$, and the idea of the versor is not distinguished from that of the vector.

* A paper read before the meeting of the American Mathematical Society, January 26, 1895. (Abstract.)

METEOROLOGY.

Neudrucke von Schriften und Karten ueber Meteorologie und Erdmagnetismus.

Dr. G. Hellmann, of Berlin, has undertaken the republication of certain old and rare writings relating to meteorology and terrestrial magnetism which have an important bearing on the history and development of these sciences. Very rare or typographically interesting works are printed in facsimile. Each reprint is preceded by an introduction, containing a general description of the book and its author. Although facsimile publications generally are so dear that only connoisseurs are able to buy them, yet, owing to the aid of the German Meteorological Society and its Berlin branch, the reprints are offered at a relatively low price by A. Asher & Co., Berlin. A few copies may also be had of A. L. Rotch, Blue Hill Observatory, Readville, Mass., at the publishers' prices. Each year one or two of the reprints will be issued, but the whole number will not exceed twelve. The following have already appeared:

No. 1. *Wetterbuechlein von wahrer Erkenntniss des Wetters.* REYNMAN, 1510. 41 pages introduction and 14 pages facsimile. Price 6 M. = $1.50.

This is the oldest printed meteorological work in the German language and was very popular, having 34 editions in seventeen years. Nevertheless, it is now so scarce that hardly thirty-six copies can be found.

No. 2. *Récit de la Grande Expérience de l'Equilibre des Liqueurs.* BLAISE PASCAL. Paris. 1648. 10 pages introduction and 20 pages facsimile. Price 3 M. = 75 cents.

This little work is of the greatest impor-