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IX. *Specific Inductive Capacities of Water, Alcohol, &c.*
By J. HOPKINSON*.

IN the December number of the Philosophical Magazine is a short article by Prof. R. A. Fessenden on the Measurement of the Specific Inductive Capacities of Water, Alcohol, &c. In this article he states that the high values found by Cohn and Arons and others for water, alcohol, &c. are not correct, but that the true values are in every one of these substances very nearly equal to that called for by Maxwell's theory. He also states that all the determinations of such substances as sulphur, &c. are incorrect. The observations said to be incorrect are not those of a single observer, but of many whose results are in good accord.

Taking solids first, it has been shown that the capacity of light flint-glass at ordinary temperatures is the same whether the time of charge is $\frac{1}{20,000}$ second, or $\frac{1}{2}$ second, that it is independent of the potential of the charge, and that its value is about 6.7†. It is also well known that this glass insulates so well that it will hold its charge for months‡. Is it suggested that these results are vitiated by electrolytic polarization or by a hypothetical laminated structure of the material? The specific inductive capacity of ice has been determined by Bonty§. He finds 78, practically the same value as Cohn and Arons find for water. But the resistance is from 10^5 to 10^6 times as great as that of water, which quite precludes the suggestion of electrolytic polarization.

Turning to liquids, we have a large number of determinations which also deviate from Maxwell's law. Take, for example, castor-oil and ether. Both insulate well enough to make certain that electrolytic polarization does not affect the result. Quincke determined the capacity of ether|| by three very different methods and found it in each case about 4.7; my result by a fourth method was 4.75. For castor-oil I obtained by two very different methods 4.78 and 4.82¶. All these results deviate much from Maxwell's law making use of

* Communicated by the Author.

† Phil. Trans. vol. clxxii. p. 372, and Gray's 'Absolute Measurement in Electricity and Magnetism,' vol. i. p. 473.

‡ Phil. Trans. vol. clxvii. p. 610.

§ *Comptes Rendus*, p. 533, March 7, 1892.

|| Gray, p. 483.

¶ Phil. Trans. (*loc. cit.*), and Proc. Roy. Soc. October 1887.

refractive indices for visible rays, and render the results of Cohn and Arons and the independent results of Tereschin for water not improbable *à priori*. Indeed, I think much more evidence will be needed than Prof. Fessenden has given before they are doubted.

Prof. Fessenden also states that pure water insulates as well as indiarubber! The highest recorded resistance for water is far below that of indiarubber.

I would not have troubled you with this note were it not that anything appearing in the Philosophical Magazine carries authority, and if inaccurate is calculated to mislead.

X. On Colonel Hime's 'Outlines of Quaternions.'

To the Editors of the Philosophical Magazine.

GENTLEMEN,

I CANNOT agree with your reviewer in holding that paragraph 11 of the 'Outlines' is not quaternions. The equation

$$i=j=k=\sqrt{-1}=-i=-j=-k,$$

as your reviewer says, may be nonsense; nevertheless it follows from the fundamental principles of quaternions as laid down by Hamilton and Tait. It is said that $i^2=-1$ and $j^2=-1$; therefore it follows that $i^2=j^2$, unless in quaternions the axiom does not hold which says that things which are equal to the same thing are equal to one another. But from $i^2=j^2$ it follows that $i=+j$ or $-j$, for we are told that it is only the commutative law of all the laws of algebra which breaks down, and here that peculiarity does not enter. By extending the same reasoning to the other two pairs, we obtain

$$i=j=k=\sqrt{-1}=-i=-j=-k.$$

How does your reviewer demonstrate that it is nonsense? He says that i, j, k have already been defined as co-perpendicular unit-vectors, and to say that they are equal is to rob them arbitrarily of their most characteristic feature, so that they are no longer what they were defined to be. Yet a few sentences before this same writer defends Hamilton's no less arbitrary violation of the definition of a vector, which does not indeed rob it of any of its meaning, but piles on it what