LETTERS TO THE EDITOR.

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A Penalty on Research.

WE are frequently told that there is no difficulty in being accorded the use of small quantities of absolute alcohol, duty-free. While professor at University College, it was possible for me to procure what I required, duty-free, for a permit had been granted to the college. Now, working in my private laboratory here, I am refused the privilege. Having applied for permission to be allowed to buy not more than two gallons a year of absolute alcohol, free of duty, the secretary, in a letter of February 1, says:—"The Commissioners regret their inability to grant you the use of pure spirit, duty-free."

Now, sir, I have lately been doing a good deal of work for various departments of the Government free of charge; and for some of this, absolute alcohol is, if not a necessity, at least a great convenience. Moreover, my laboratory servant, who is, by the way, a teetotaler, is serving with the colours.

I regard this action of the Customs Department as a penalty on research. No doubt it will be said, if an exception (exception to what?) is made in one case, why not in all? The privilege might be abused. I think not. Such a permit might be granted only to persons who are known to be actually engaged in research, and whose *bona fides* is attested.

The question of free alcohol is, you will observe, still unsettled; and I hope that some action will be taken to put an end to such folly. WILLIAM RAMSAY.

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The Spectra of Helium and Hydrogen.

IT has become a general supposition that the validity of Bohr's theory of the spectra of hydrogen and helium would be definitely proved if certain faint components very close to the hydrogen lines given by Balmer's formula could be found experimentally. On the other hand, if the components were not found after exhaustive search, the theory would be disproved. This supposition is quite incorrect, and in view of the remarkable paper by Mr. E. J. Evans in the current number of the *Philosophical Magazine*, which describes the successful discovery and measurement of these components, it becomes a matter of urgency to indicate at once why such components can give no test of any theory of spectral production.

Into the vexed question of the agent producing the line λ 4686, and the Pickering series—whether it be hydrogen or helium— it is not necessary to enter, for the conclusions are the same in either case. We have two alternatives to consider: (1) that the lines are due to helium, and (2) that they are due to hydrogen. Let us, in the first place, take the first alternative, which has been rendered so probable by Fowler in his recent Bakerian lecture. In that case, the line λ 4686 belongs to an enhanced line series with 4N as the Rydberg constant instead of N. It is strictly analogous, as Fowler points out, to his new series of magnesium, commencing with λ 4481, and we must expect an analogous behaviour. Now no spectroscopist questions to-day the universal validity of the combination principle in spectra, developed by Ritz and Paschen, and some well-defined types of combination series are known. In particular, there is a well-marked spark series in magnesium formed by combinations of the type $3f-mf$, in the usual notation, where nf is the variable part of a line in the "4481" series. In other words, the wave numbers in this series—a comparatively strong one—are differences of the wave numbers of lines in the "4481" series. Fowler has measured seven successive members of this series (Bakerian Lecture, p. 253). If we calculate the corresponding series for helium from the "4686" series, we obtain precisely the Pickering series and the new components measured by Evans. This calculation is independent of *any* theory of the production of series. One series must necessarily be accompanied by the other. In this particular combination, the result is even independent of any expression, empirical or otherwise, of the series by a formula. The difficulty of observing the lines in no way contradicts this necessary origin. They may have another origin in addition, and be really twofold, but since this process must produce them even in the absence of any other, their existence cannot in consequence contribute to the establishment either of Bohr's or of any other theory.

The second alternative is to return to Rydberg's view that half the "4686" series is a principal series of hydrogen, and that the other half is a new principal series. The writer must here insist that he is not expressing a belief in Rydberg's view, though, in his opinion, sufficient justice has not been done to this alternative, which, from the point of view of exact formulæ, is not really inferior to the other, although the need for the presence of helium in the experimental isolation of the lines is against it. The important point is that even if this now somewhat discredited view is correct, the new components near the hydrogen lines must exist, and in *exactly* the same calculated positions as before. They exist again as combination tones, of the type $3P-mP$, where P is now the principal series of hydrogen, and can be calculated at once by subtracting the wave numbers of the "4686" series, or, in fact, of just the half of it which Rydberg designated as the principal series. This combination from the principal series is well known in the alkalis lithium and sodium, just below hydrogen in the periodic table. The lines could only be expected to occur, however, when λ 4686 is strong, as in the experiments of Evans.

While, therefore, the isolation of these lines is a great step in the advancement of our knowledge of hydrogen or helium, it cannot prove that they are helium lines, and although they were predicted by Bohr's theory, they were, in fact, previously predicted by the very existence of the "4686" series, whatever its interpretation. While sharing the general admiration for the great simplicity of Bohr's theory as applied to the Pickering and "4686" series, the writer must nevertheless point out the one, and apparently the only, method by which he believes it can be proved or disproved. This is by interference measurements of the first four or five lines in the "4686" series, from which the value of Rydberg's constant can be calculated exactly, and compared with Curtis's value for hydrogen. The lines are not at present measured accurately enough for this purpose.

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University of London, King's College, February 4.

On the History of a Notation in Trigonometry.

THE interpretation of formulas in the trigonometry of plane and spherical triangles is greatly simplified by the expedient of designating the sides by the same letters, respectively, as the angles opposite those sides