

Letters to the Editor.

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Atomic Weight of Cæsium: Use of the Word 'Mass-spectrograph'.

THE first mass-spectra obtained from cæsium by means of a hot anode showed only one line of mass number 133. As I pointed out,¹ the conditions of the experiment precluded any accuracy of measurement sufficient to decide whether the chemical atomic weight then and since accepted, 132·81, did or did not represent the weight of the atom. Quite recently, K. T. Bainbridge,² using Dempster's method of analysis, has confirmed the simplicity of cæsium to such a degree as to make him confident that no other isotope exists to the extent of 0·3 per cent. As he points out, on this view the atomic weight of 132·81 would imply a packing fraction of -14·3. Such a figure would be so completely abnormal that it seemed desirable that it should be tested by direct and trustworthy means.

The obvious method is to photograph Cs 133 between Xe 132 and 134. To be really convincing, the lines must be produced during the same exposure, and as the alkali metals and the inert gases are, from the point of view of mass ray technique, the extreme and mutually exclusive types of element, this is by no means easy. After many trials, I have now succeeded in making a form of discharge tube capable of producing the anode rays of cæsium at the same time as the gas rays of xenon. Furthermore, by varying the quantity of the latter element present and the times of exposure, mass-spectra have been obtained which enable the masses to be compared with an accuracy of 1 in 10,000. The results are conclusively against any abnormality. If we assume the packing fraction of xenon to be $-5\cdot3 \pm 2\cdot0$, as already determined, that of cæsium is $-5\cdot0 \pm 2\cdot0$, the weight of the cæsium atom ($O^{16} = 16$) is 132·933, and using Naudé's factor of 1·25 in 10,000 to transform to the chemical scale we get

$$\text{At. Wt. of Cæsium} = 132\cdot91 \pm 0\cdot02.$$

In further reference to Bainbridge's letter, I should like to lodge an objection to his application of the word 'mass-spectrograph' to Dempster's form of analysis. This word I coined in 1920 to describe an instrument which by its peculiar sequence of electric and magnetic fields eliminated the effect of varying velocity and gave a spectrum dependent upon mass alone. Dempster's apparatus, described two years earlier, is essentially an application to the analysis of positive rays of the well-known and widely used principle of semicircular magnetic focusing. Such an instrument gives a magnetic spectrum which depends upon momentum and not upon mass *per se*. The fact that it is the standard method for determining the energies of beta particles makes this sufficiently obvious. The use of the word mass-spectrograph, unqualified in any way, to an apparatus not using in any manner the principle implied in it, appears to me to be a misleading and undesirable practice.

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¹ *Phil. Mag.*, **42**, p. 440; 1921.
² *Phys. Rev.*, **36**, p. 1668; 1930.

Petroleum and Alpha Radiation.

IN NATURE of Feb. 28 (127, p. 317) reference was made to my recent address before the American Association for the Advancement of Science,¹ as reported by Science Service. Lest the 'novelty' of the possible rôle of alpha radiation in the interaction of hydrocarbons in the earth's crust obscure its true relative importance, I should like to make a further communication and to suggest a new way of accounting for the absence of free hydrogen in natural gases.

In the first paper of Lind and Bardwell on the action of alpha particles on saturated hydrocarbons,² it was pointed out that similar reactions *must* take place in the earth's crust if conditions exist where alpha particles bombard hydrocarbons. While these conclusions were then based on experiments with gaseous hydrocarbons, there was indirect evidence that the reactions extend also to the liquid members. More recent work by W. T. Richards³ in the laboratory of Sir Ernest Rutherford gave direct proof that this is true not only for liquid but also for solid paraffins and that hydrogen is the principal gaseous product. Calculations from Richard's results⁴ showed that even the quantitative yield of hydrogen per ion pair is certainly not less than half of that in the gases.

Hydrogen is therefore the most abundant gas produced by the reaction, and since Lind and Bardwell had shown⁵ that it does not interact further with unsaturated hydrocarbons under alpha radiation, it becomes an important criterion of reaction unless it is removed in some other way.

The fact, however, that free hydrogen is conspicuously absent in natural gases (except in some volcanic regions) led us to conclude that the problem of its disposal must be met before even a partial radioactive origin of petroleum could be accepted. Under catalytic conditions which are quite possible, hydrogen could recombine with liquid unsaturates, but this would account for less than half of it, assuming the initial hydrocarbons to have been saturated, since all the hydrogen liberated in condensation to higher saturates would still remain free.

If, however, the original hydrocarbon (or hydrocarbons) be assumed to have been unsaturated (or if unsaturates have been produced from saturates by the thermal elimination of the necessary amount of methane), the complete catalytic removal of hydrogen under high pressure and high temperature conditions becomes possible, because the amount of hydrogen liberated by alpha rays is much smaller from the unsaturates—far less than the amount required for saturation. Moreover, we do find petroleum to contain unsaturated members, possibly indicating an initial excess of unsaturation.

Although this suggestion as to disposal of the hydrogen may be regarded as making the radioactive origin of part of our petroleum more probable, the abundance of methane in natural gases associated with petroleum seems to indicate that the *thermal* interaction of hydrocarbons at high pressures and temperatures suggested by Prof. H. A. Wilson⁶ is perhaps the more prolific source of petroleum, since, according to his theory, *methane* would be the lower terminal member.

The recent note on this subject in NATURE also raised the pertinent question: . . . "is radioactivity a potential function in the type of environment and at the comparatively shallow depth in the crust which modern views seem now to imply for the birth of the oil globule?" It scarcely appears possible to answer this question definitely, but certainly we would not be justified in a negative answer. The distribution of a low radium content in the earth's crust is so general and so constant that its action extended over