

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

An Isotope of Oxygen of Mass 17 in the Earth's Atmosphere.

SINCE we reported the presence of an isotope of oxygen with mass 18 in the earth's atmosphere (NATURE, 123, 318; 1929) we have found further confirmation. Mr. Harold D. Babcock has sent us thirty-four lines which were withheld from publication by Dieke and Babcock (*Proc. N.A.S.*, 13, 670; 1927) because it was not known that they were due to oxygen. Twenty-seven of these are due to the alternate rotation levels of the 18-16 oxygen molecule. Thus the 18-16 molecule has every rotation state where the 16-16 molecule has only alternate levels. Such an excellent confirmation of the predictions of wave mechanics in this regard has not heretofore been possible since the presence of nuclear spin usually permits all states to exist although not in equal amount. The more complete discussion of the data will appear elsewhere (*Jour. Am. Chem. Soc.*, May 1929). In the meantime Babcock, who obtained the data at Mount Wilson Observatory, has re-examined his plates and also obtained additional measurements. He has found a number of extremely weak lines in addition to extending the various 18-16 series, and has kindly permitted us to examine his manuscript in advance of publication (*Proc. N.A.S.*).

Babcock suggests that his new lines may be due to the forbidden 16-16 alternate rotation levels, although, as he points out, they fail to occupy the correct positions by several times his experimental error.

We have found that these lines originate from a molecule consisting of an atom of mass 17 in combination with one of mass 16. The normal state of this molecule has one-half unit of vibration, and both odd and even rotation levels exist. Each of these facts is in accord with the theory of wave mechanics.

The equations for the isotopic displacement are the same as previously given (NATURE, 123, 318; 1929) except that 1.11 cm.^{-1} and 0.0294 cm.^{-1} should replace the values 2.12 cm.^{-1} and 0.0556 cm.^{-1} respectively. Out of 22 new weak lines we find that 19 belong to oxygen 16-17. The algebraic deviation of observed minus calculated lines is -0.03 cm.^{-1} with a maximum deviation of 0.14 cm.^{-1} .

It is apparent from the comment of Aston (NATURE, 123, 488; 1929) with regard to oxygen 18 that a mass spectrograph is unreliable in an initial or confirmatory investigation of isotopes present in very small amount. It appears that the various known isotopes of the elements, their several chemical combinations and multiple ionisations, are not eliminated by existing technique, and suffice to explain nearly any future observation that can be made on an isotope present in very small amount. This is, however, not the case in band spectroscopy, where the very characteristic fine structure having been found for an abundant isotope will lead to an equally characteristic counterpart. We may thus conclude with certainty that oxygen isotopes 17 and 18 do exist in the earth's atmosphere.

Babcock has carried out some very accurate intensity measurements to assist in the estimation of relative amount. As we have pointed out in our more detailed paper (to appear *Jour. Am. Chem. Soc.*, May 1929) 18-16 molecules may be slightly polar, due

to zero point vibration. This would be expected, since the centre of mass does not coincide with the geometrical centre. Such polarity may increase the absorption coefficient of the 18-16 or 17-16 molecules. However, intensity measurements should lead to a maximum value. Babcock estimates oxygen 18 as present to one part in 2500. He has, however, overlooked a factor of two in his calculation, so that the estimate should be one part in 1250, as a maximum. This factor is due to the fact that the 18-16 molecules have twice as many states in which to exist as have the 16-16 molecules.

From Babcock's estimate of the relative intensity of the lines which are due to the 17-16 molecule we estimate its abundance as about one part in 10,000 as a maximum.

Oxygen mass 17 has been reported by Kirsch and Petterson (*Ark. f. Mat. Astron. och Fysik*, Stockholm, 19, 15, 1-16; 1925; *Phys. Z.*, 26, 457; 1925) and by Blackett (*Proc. Roy. Soc.*, A, 107, 349; 1925) from data obtained on collisions between alpha particles and nitrogen nuclei. These collisions occasionally lead to combination with subsequent elimination of a proton leaving oxygen 17. These experiments did not indicate the stability of oxygen 17, except that Blackett was able to show a life of at least 0.001 sec.

A full account of our work will appear elsewhere.

W. F. GIAUQUE.

H. L. JOHNSTON.

Department of Chemistry,
University of California,
Berkeley, California,
April 27.

The Heat Production of Crustacean Nerve.

IN my Ludwig Mond Lecture, published in NATURE of May 11, I referred to the experiments of Furusawa on the 'depolarisation' of crab's nerve by stimulation, and to the manner in which the 'polarisation' (as shown by the injury current) increases again to its original value in the presence, but not in the absence, of oxygen. In a paper by Furusawa, shortly to be published in the *Journal of Physiology*, it will appear that this recovery process occupies a time of the order of half an hour. I have recently succeeded in measuring the heat produced by crab's nerve, as the result of a 5 to 10 seconds' stimulus. Some 98 per cent of this heat occurs in the recovery phase, only 2 per cent during the actual stimulus: the recovery heat production lasts for 20 to 30 minutes at room temperature. There is no doubt, therefore, that the process in which the injury current, diminished by stimulation, returns to its original value is accompanied by a relatively large liberation of energy.

A striking fact is the small amount of heat set free in the initial phase, that is, during the passage of the impulse. If we regard the nerve wave as accompanied by a surface change in the fibre which momentarily allows electrical contact to occur between inside and outside (it is difficult to picture the 'action current' otherwise), then activity will allow an equalisation of concentration of ions to occur between the two sides, a process which must be reversed during subsequent recovery. The mixture of two salt solutions, say of potassium chloride and sodium chloride, involves very little change in total energy: considerable work, however, may be required to separate them again, and this work will require a provision of energy, and in any actual process the liberation of heat.

The crustacean nerve, as shown by Levin and by Furusawa, is highly fatigable, at any rate in respect of its electric change. Corresponding to this, Meyerhof