quantities in parentheses indicating extrapolated values. Unless otherwise noted the wave-lengths are those given in the International Critical Tables.[2] A comparison of the new estimates with the values secured from the quantum defect relationship (Table IV) shows that only in the case of the $1^2S-2^2P_2$

TABLE IV.   *Ultimate   lines   of   element   87.*

Method	Red doublet		Violet doublet	
	1^2S- 2^2P_2	1^2S- 2^2P_1	1^2S- 3^2P_2	1^2S- 3^2P_1
Quantum defects	7460	8130	4260	4310
Sub-group ratios	7150	8104	4225	4328

line of the red doublet do the two methods yield markedly different results. The doublet separations of 1646ν in the red, and 558ν in the violet region are in good agreement with independent estimates for these intervals, the mean of which are $1690\pm100\nu$ and $550\pm50\nu$.[3]

Judging from the nature of the agreement between the ced and observed spectral lines in the ca   the radium spectrum, it may be concluded that in the spectrophotographic examination of mineral concentrates lines in the region of 4225 ± 15A and 4328 ± 15A will be observed should the sample contain ekacaesium. The investigation also indicates that the first doublet of the principal series will appear in a region that is better adopted for its visual observation than has been supposed by previous workers.[4]

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      May 19, 1932.

[2] Inter. Critical Tables **5**, 323 (1929).

[3] Detailed calculations will be published in the July or a later issue of the Journal of the American Chemical Society.

[4] K. T. Bainbridge, Phys. Rev. **34**, 752 (1929); J. Papish and E. Wainer, J. Am. Chem. Soc. **53**, 3818 (1931); W. F. Meggers, Science Supplement **74**, No. 1926, 10 (1931)

Absorption of Oxygen in the Region of Short Wave-lengths

The dispersion of oxygen between the visible and 1900A can be described quantitatively[1] by two resonance wave-lengths $\lambda_1 = 1469$A and $\lambda_2 = 544$A with the corresponding number of oscillators $f_1 = 0.20$ and $f_2 = 5.93$.

In order to study the physical significance of this result we have investigated the absorption of oxygen down to 300A by means both of a small fluorite and a large grating spectrograph. The latter, designed by Compton and Boyce,[2] was used for qualitative measurements only. Flowing oxygen was introduced into the spectrograph at pressures between 0.25 and 0.002 mm. Besides the oxygen, only some helium, at about 0.001 mm pressure, coming from the light source, was in the spectrograph. The light source was an uncondensed capillary discharge at 0.1 mm pressure in helium containing perhaps one percent of impurities. This gave emission lines distributed over the whole of the spectral range investigated. The conspicuous impurities were oxygen, hydrogen and nitrogen.

[1] R. Ladenburg and G. Wolfsohn, Phys. Rev. **40**, 123 (1932).

[2] K. T. Compton and J. C. Boyce, Phys. Rev. **40**, 1038 (1932).

The results confirm some of the earlier experiments of Lyman, Leifson and Hopfield. There are two strong absorption regions in oxygen, one between 1750 and 1300, with a maximum in the neighborhood of 1400A, and another below 1100A and still quite strong at 300A, separated by a gap which is transparent for a 4 meter path of pure O_2 at 0.25 mm pressure. As nitrogen proved to be also transparent in this region, it seems hopeful to use wave-lengths between 1300 and 1100A for photochemical reactions, the light source and the reaction chamber being separated by CaF_2 or LiF windows and a few millimeters of air. Such a light source is under construction.

The two resonance wave-lengths calculated from the dispersion measurements correspond obviously to the two observed absorption regions. Their positions are in fair agreement with the estimated centers of gravity of the absorption bands.

For quantitative measurements we used a fluorite spectrograph, like one constructed by Cario and Schmidt-Ott,[3] the hydrogen spectrum of a capillary tube as light source and

[3] G. Cario and H. D. Schmidt-Ott, Zeits. f. Physik **69**, 719 (1931).

the photographic photometric method to determine the absorption coefficient in the continuous absorption of the Schumann-Runge bands. The dissociation of the O_2 molecule by the influence of light in this region of the spectrum is so strong that by illuminating a closed cell of 10 cm length for 1450A to about one-half of its intensity, i.e., as much as metallic absorption. The absorption in the band lines is incomparably smaller. This is just what we should expect from the above mentioned dispersion measurements as well as from the application of the Franck-Condon principle to the potential energy
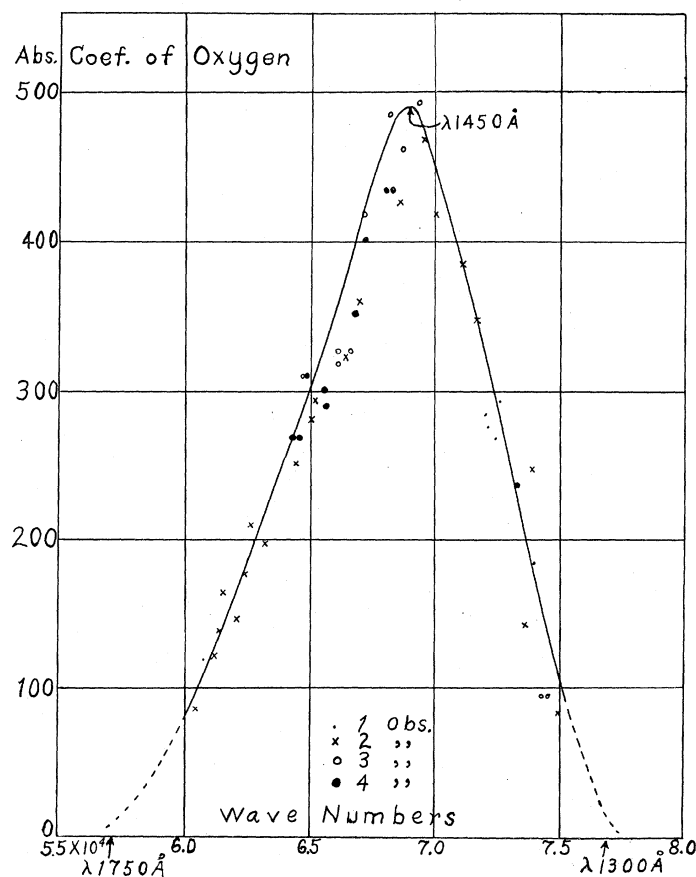

Fig. 1.

some minutes the greater part of the oxygen disappears, the O atoms probably being absorbed by the walls of the cell.

The results of our measurements are shown in the graph, the abscissae being wave numbers $(1/\lambda)$, the ordinates, absorption coefficients α defined by the equation

$$I = I_0 \epsilon^{-\alpha l}$$

and reduced to 76 cm pressure and 0°C, l being in cm. Therefore a length of 0.0014 cm of O_2 at NPT reduces light of wave-length

curves of O_2 calculated by Morse[4] and Stueckelberg.[5]

Finally we can compute from the graph of the absorption coefficient the f value, assuming the classical relation between absorption and dispersion[6]

[4] P. M. Morse, Phys. Rev. **34**, 57 (1929).

[5] E. C. G. Stueckelberg, Phys. Rev. **34**, 65 (1929).

[6] R. Ladenburg, Verh. d. D. Phys. Ges. **16**, 769 (1914); Zeits. f. Physik **4**, 451 (1921).

$$\int \alpha d\nu = \pi N f e^2 / mc = f \times 7.12 \cdot 10^{17}$$

where N means the number of molecules at NPT. Thus we get for the absorption of oxygen in the Schumann region the value

$$f = 0.193 \text{ and } \lambda_{max} = 1450A$$

in very good agreement with the conclusions drawn from the dispersion curve.

Regarding the second resonance wavelength in the region of 544A, our qualitative measurements by means of the grating spectrograph show that the absorption coefficient is here of the same order of magnitude as in the Schumann region. On the other hand the corresponding f value as deduced from the dispersion measurements turned out to be about 30 times as large as f_1. This can be accounted for if we assume that the absorption region extends from 1100A to 160A, an assumption compatible with our experiments which showed a quite considerable absorption at 303A with a column of 4 meters of oxygen at 0.002 mm pressure.

So we may say that our absorption measurements of the O_2—molecule confirm the conclusions drawn from the dispersion curve and the classical relation between absorption and dispersion, heretofore verified only for monatomic gases.

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Measurements of the Height of a Large Drop of Mercury

A recent paper in this journal by the present writer[1] gave for the surface tension of mercury in vacuum values ranging from 438.4±0.3 dynes per cm at 12.5° to 423.9 ±0.6 dynes per cm at 67°—determined by the flat-drop method. The accuracy of results obtained by this method have been questioned by R. S. Burdon in a letter to Nature.[2] His contention is that there is a possibility that the readings were taken on "the lowest curve of the drop which will reflect rays coming from the top of the ground-glass window," instead of on the real summit of the drop. Needless to say a point so important as the exact definition of the top of the drop was not overlooked in the original experiment. Between March 31 and July 26, 1930, fifty-four sets of readings, each set consisting of at least nine trials, were discarded chiefly because the definition of the top of the drop was not considered sufficiently exact. Two layers of heavy asbestos paper wrapped around the large tube containing the dish of mercury restricted the entrance of light to a circular opening less than 1 cm in diameter. As the top of the opening was approximately 1 mm above the top of the drop the source of error mentioned by Burdon was practically eliminated.

However, in spite of the care taken in the original experiment, to ascertain the true top of the drop, efforts have since been made, in accordance with Burdon's suggestion,[2] to check the readings previously taken. A summary of the work follows.

The apparatus was reset and the lighting conditions duplicated. The horizontal microscope was focused on the center of the drop's meniscus, the line which gives the sharpest focus. A set of readings was taken. Then the light was blocked out from the top of the window until the verge of invisibility was reached. The averages given below speak for themselves.

Full window......... 0.8182 ±0.0001 cm
1 cm window .... 0.8183 ±0.0001 cm
Blocked window.... 0.8183 ±0.0001 cm

A facsimile of the dish was set up in the open laboratory. The room was darkened and the lamp encased in a box the only opening of which was covered with unglazed paper. The top of the drop was first located by means of oblique lines[3] ruled on a card which was placed directly behind the dish. The cross hairs, focused on the intersection of the slanting lines and their reflection, remained unchanged upon the removal of the card. Nor did the use of a spherometer point, as suggested by Burdon, produce any change in the setting.

As a further test that the conditions under which readings were taken on the top of the drop were not precisely the same as those de-

[1] M. Kernaghan, Phys. Rev. **37**, 990–997, (1931).

[2] R. S. Burdon, Nature **128**, 456, (1931).

[3] S. G. Cook, Phys. Rev. **34**, 513–520, (1929).