and A_1 and A_2 are respectively the areas of the curve measured for small lengths x_1 and x_2 at either end of the range.

The following gives a comparison of the frequencies of the various degrees of cloudiness, as given by observation, and by the areas of the curve:—

Degree.	Observation.	Calculation.
0	751	803
1	179	142
2	107	72
3	69	60
4	46	51
5	9	50
6	21	55
7	71	60
8	194	85
9	117	153
10	2089	2122

Considering the rough nature of cloudiness observations, the agreement must be considered fairly good, and very probably the smooth results of the theory* are closer to the real facts of the case than the irregular observations. The chief interest of this Note lies, however, in the fact that it shows the capacity of the theory of skew variation already developed to cover novel and unusual types of frequency.

"On the Occlusion of Hydrogen and Oxygen by Palladium."

By Ludwig Mond, Ph.D., F.R.S., William Ramsay, Ph.D., LL.D., Sc.D., F.R.S., and John Shields, D.Sc., Ph.D. Received December 8,—Read December 16, 1897.

(Abstract.)

During their investigations on the nature of the occlusion of gases by finely divided metals, and in particular on the occlusion of hydrogen and oxygen by platinum black, the authors have had occasion to examine the behaviour of palladium to these gases.

The palladium was employed in three states of aggregation, viz., in the form of (*a*) black, (*b*) sponge, and (*c*) foil. Palladium black, prepared in the same way as platinum black, contains 1·65 per cent. of oxygen, or, taking the density of palladium black as 12·0, 138 volumes of oxygen. It differs from platinum black, however,

* The diagram on which the percentile curves are roughly drawn also indicates the amount of agreement by a histogram.

inasmuch as the oxygen cannot be removed *in vacuo* at a dull red heat, and consequently had to be determined in the ignited substance by passing hydrogen over it and weighing the water produced. Palladium black dried at 100° contains 0·72 per cent. of water, and hence, on the assumption that the oxygen exists as PdO, we have for the analysis of palladium black—

Pd	86·59 per cent.	
PdO	12·69 „	= 1·65 per cent. O_2
H_2O	0·72 „	

On heating in an atmosphere of oxygen, palladium black goes on absorbing oxygen at least up to a red heat, with the formation of a brownish-black substance, which does not again lose its oxygen at a dull red heat *in vacuo.* The amount of oxygen absorbed (nearly 1000 volumes) was about one and a half times as much as corresponds with the formula Pd_2O, and if the ignition had been sufficiently prolonged, the whole of the palladium would probably have been converted into the oxide PdO.

Palladium black, when exposed to hydrogen gas, absorbed over 1100 volumes, but of this only 873 volumes were really occluded, the remainder having formed water with 139 volumes of oxygen originally contained in the black, which is in good agreement with the direct gravimetric estimation.

Of the hydrogen occluded, about 92 per cent. was pumped off slowly at the ordinary temperature, and almost the whole of the remainder at 444°. Increase of pressure of the hydrogen from one atmosphere up to 4·6 atmospheres had no influence on the quantity occluded at the ordinary temperature.

The pure palladium sponge remaining in the experimental tube after the above experiment was over occluded 852 volumes of hydrogen, and about 98 per cent. of this was extracted *in vacuo* at the ordinary temperature.

New palladium foil behaved in a very peculiar fashion. At first it scarcely occluded any hydrogen even after ignition in the gas and subsequently cooling down. It was therefore charged and discharged several times electrolytically with hydrogen, but still it persistently refused to occlude any appreciable quantity when replaced in an atmosphere of hydrogen.

After powerful ignition in the blowpipe flame, when it was probably oxidised and then again reduced at a still higher temperature, it was introduced once more into the experimental tube. It immediately occluded a considerable quantity of hydrogen, and by maintaining the temperature between 100° and 130°, a large additional quantity was slowly absorbed. On cooling down to the ordinary temperature, hydrogen was again occluded, and it was finally found

to have taken up 846 volumes, *i.e.*, approximately the same quantity as the black or sponge.

The hydrogen occluded by palladium foil is given off again very slowly at the ordinary temperature *in vacuo*, but rapidly and almost completely at 100°.

The paper contains some attempts to explain the extraordinary behaviour of palladium foil.

The heat evolved on the occlusion of hydrogen by palladium black was measured in an ice calorimeter (temperature of the room 20—24°) in nearly the same way as the corresponding heat of occlusion of hydrogen by platinum black, thereby avoiding errors due to the pre-existence of oxygen in the substance.

Favre's statement that the heat of occlusion remains constant for the different fractions of hydrogen occluded was confirmed, and it was found that +46·4 K (4640 g. cal.) were evolved per gram of hydrogen occluded.

The authors consider that this number may be taken as correct within 1 per cent., and compare it with the different values found by Favre and those calculated by Moutier and Dewar.

If the external work done by the atmosphere be eliminated, the heat evolved per gram of hydrogen occluded becomes +43·7 K.

The heat evolved per gram of oxygen absorbed was also determined in an indirect manner, and found to be +11·2 K (1120 g. cal.).

This number, referred to 16 grams of oxygen, lies intermediate between the values given by Thomsen for the heat of formation of palladious and palladic hydroxides, and may be consistent, considering the accuracy of such measurements, with the formation of either of these hydroxides or with a mixture of both. In any case it is of the same order of magnitude, and taken in conjunction with the behaviour of palladium black when heated in an atmosphere of oxygen, is undoubtedly in harmony with the view that the absorption of oxygen by palladium black (and probably also by platinum black) is a true phenomenon of oxidation.

The authors have also investigated the atomic ratio—palladium : hydrogen for fully charged palladium black, sponge, and foil, and give in tabular form the corresponding ratios deduced from experiments by Graham and Dewar in which wire and block palladium were charged with hydrogen electrolytically. They have arrived at the conclusion that no matter whether the palladium exists as black, sponge, foil, wire, or compact metal, or whether it is charged by direct exposure to hydrogen gas (the proper conditions being observed), or charged electrolytically, the amount of hydrogen occluded in each case is approximately the same, the atomic ratio varying between 1·37 and 1·47.

Hoitsema has shown that Troost and Hautefeuille's deduction that a compound exists having the formula Pd_2H is not warranted. The constancy of the heat of occlusion over the whole range of absorption is also opposed to the view that such a compound is formed.

The composition of fully charged palladium hydrogen corresponds closely with the formula Pd_3H_2 first suggested by Dewar. The principal and almost only evidence, up to the present, in favour of the formation of such a definite chemical compound is to be found in the approximation of the above atomic ratios to the theoretical value 1·5, required by the formula Pd_3H_2. Although Hoitsema's arguments may be equally well directed against the existence of this compound, the authors consider that additional and independent evidence is desirable, and hope to be able to provide it.

It is also shown that the heats of occlusion of hydrogen in platinum and palladium black are not in favour of the view which has sometimes been put forward that the heat of occlusion of a gas represents the heat of condensation or liquefaction of the gas in the capillary pores of the absorbing substance, or the heat of solidification or fusion.

"On the Determination of the Indices of Refraction of various Substances for the Electric Ray. II. Index of Refraction of Glass." By JAGADIS CHUNDER BOSE, M.A., D.Sc., Professor of Physical Science, Presidency College, Calcutta. Communicated by LORD RAYLEIGH, F.R.S. Received October 1,—Read November 25, 1897.

In my previous paper, read before the Royal Society on October 20, 1895,* I described a method of determining the indices of refraction of various substances for electric radiation, the principle of which depends on the determination of the critical angle at which total reflection takes place. A semi-cylinder of the given substance was taken, and the angle of incidence gradually increased till the rays were totally reflected. The experiment was repeated with two semi-cylinders, separated by a parallel air-space. The advantage of the latter arrangement was that the image cast by the two semi-cylinders remained fixed. The image underwent extinction when the angle of incidence attained the critical value.

The determination of the indices of refraction for long electric waves derives additional interest from Maxwell's theoretical relation between the dielectric constant and the refractive index for infinitely long waves. The relation $K=\mu^2$ has, however, been found to be fulfilled in only a few instances. The value u_∞ is usually deduced

* *Vide* 'Roy. Soc. Proc.,' vol. 59, p. 160.