

This photometric arrangement is very convenient and rapid, inasmuch as it is unnecessary under these circumstances to continually check the zero of the instrument for fear that the relative intensity of source and comparison light may have changed on account of fluctuations in the potential of the lighting system, which will always give trouble unless a set of storage cells can be specially devoted to the work.

*Testing Procedure.*

The resolution test (1) and the field of view determination (2) are made by an observer from a raised platform, so that he can look over the heads of the other persons in the laboratory. In the case of the resolution determination the line of sight passes through and just under the tops of two doorways. The scale for the field of view determination is set on the opposite wall of the room.

Tests (3) to (6) are made in a corner of the laboratory which is partitioned off and is somewhat less brightly lighted than the open room. The binocular is first placed on the parallelism testing piece (3) and is here focussed to make sure of having the telescopes in focus for distant objects. It is then, without change of adjustment, subjected to the other tests, little manipulation being required beyond the setting of the glass in place and the moving of the scales of the testing instruments so as to cover the distance which is to be measured.

The transmission test (7) is made in another corner of the laboratory which is partitioned off to form a small dark-room.

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## THE REFRACTOMETRY AND LISTING OF OPTICAL GLASS

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The refractometry and scheme of listing optical glass still in vogue date back to the earlier periods of spectroscopy and lens design, and are not altogether satisfactory. The data supplied is scanty, particularly in the blue and violet regions of the spectrum where the ordinary photographic surface is most sensitive. The indices for the C, D and F lines are unevenly spaced and insufficient for either interpolation or extrapolation by any known dispersion formula for more than a few glasses. The sources used (D and

A<sup>1</sup> from the sodium and potassium flames, C and F from the hydrogen tube) are convenient enough but the two former are double lines, while the latter are quite broad.

By going over to convenient modern sources (the helium tube and mercury arc) six or eight bright, sharp, well spaced lines are available. The corresponding refractive indices are ample for the determination of the constants of dispersion formulas capable of giving interpolated values to five or six decimal places. The helium tube yields bright narrow lines at 0.4026, 4471, 5016, 5876, 6678 and 7065, while the mercury arc supplies 5461 and with a little gold amalgam 6278. The few other lines present in both spectra are fainter and readily ignored. Both helium and mercury arc tubes are inexpensive. The former is easily operated on a small transformer, the latter on a three or four ampere direct current with simply a rheostat in series.

Gifford in his valuable observations on the uniformity of 35 optical glasses (Proc. Roy. Soc., May, 1912) made determinations at 13 wave lengths, the sources of which were 3 flames (Na, Li and K), 3 vacuum tubes (H, Hg and He) and 3 arcs or sparks (Pb, Fe and Cd), thus necessitating a number of changes of source for each run. The distribution of these lines may be judged from the tables reproduced below.

Wave-lengths	Telescope	Densest	Dense	Boro-
	Crown S 3418 V=60.6	Baryta Crown S 4704 V=55.7	Flint C 629 V=36.9	Silicate Flint S 3338 V=49.9
A'0.7682. Ka	1.525231	1.603759	1.602071	1.541193
B'0.7066. He	1.526730	1.605638	1.604699	1.543080
0.6708. Li	1.527775	1.606899	1.606572	1.544348
C 0.6563. Ha	1.528248	1.607501	1.607418	1.544942
D 0.5893. Na	1.530848	1.610702	1.612137	1.548146
A 0.5607. Pb	1.532211	1.612434	1.614712	1.549843
0.5461. Hg	1.533016	1.613422	1.616196	1.550829
E 0.5270. Fe	1.534128	1.614824	1.618368	1.552257
F 0.4861. H <sub>β</sub>	1.537010	1.618460	1.623982	1.555927
0.4678. Cd <sub>6</sub>	1.538584	1.620418	1.627065	1.557896
0.4415. Cd <sub>7</sub>	1.541201	1.623677	1.632327	1.561218
G'0.4341. H <sub>γ</sub>	1.542020	1.624728	1.634048	1.562291
0.4046. Hg	1.545794	1.629511	1.641979	1.567195

These data by Gifford have been used as a basis in constructing the specimen glass tables below. Both the Hartmann three-constant formula  $(n - n_0)(\lambda - \lambda_0) = C$  and a new two-constant formula  $(n - 1)^{-1} = A + B/\lambda^2$  were used, the indices at wave lengths 4046, 5270 and 6563 being

employed for the former and at 4341 and 5893 for the latter. Differences between observed and indices given by formula affect only the fifth and sixth decimal places except for C 629 in the extreme violet and red. The corrected values given are all certain to within two or three units in the sixth place.

## SPECIMEN GLASS TABLE

Wave Length	Light Crown S. 3418	Dense Barium Crown S. 4704	Dense Flint C. 629	Boro-Silicate Flint S. 3338
0.400	1.546473	1.630373	1.643431	1.568081
0.450	1.540307	1.622572	1.630532	1.560083
0.500	1.535946	1.617106	1.621896	1.554568
0.550	1.532785	1.613140	1.615810	1.550566
0.600	1.530380	1.610120	1.611269	1.547564
0.650	1.528460	1.607764	1.607798	1.545204
0.700	1.526875	1.605861	1.605037	1.543283
Dispersion Constants	$^{\circ}P = 51.3$ $^{\circ\circ}V = 95.5$	46.9 88.0	29.2 58.2	41.3 78.8
Formula Constants	$*A = 1.92985$ $B = 0.0159986$	1.68107 0.0151457	1.70059 0.023258	1.878775 0.0189075
	$** \lambda_0 = 0.1749140$	0.1796057	0.207686	0.1870975
	$n_0 = 1.512236$	1.587826	1.580383	1.525712
	$C = 0.0077075$	0.0093788	0.0121289	0.0090226

$$^{\circ}P = \frac{n_{450} - 1}{n_{400} - n_{500}}$$

$$^{\circ\circ}V = \frac{n_{550} - 1}{n_{500} - n_{600}}$$

$$* \quad 1/(n - 1) = A + B/\lambda^2 \qquad ** \quad (n - n^0)(\lambda - \lambda^0) = C$$

Corresponding with the older dispersion constant  $V = (n_d - 1)(n_f - n_c)$  are given two new ones:  $P$  for the principal photographic region 0.400, 0.450, 0.500 and  $V$  for the visual region 0.500, 0.550, 0.600. Another possible selection would be for  $P$  the region 0.400, 0.500, 0.600 and for  $V$  0.500, 0.600, 0.700—the first range mentioned is rather narrow, the latter probably too broad. The maximum intensity sensibility and the maximum luminosity for white light, for the average normal eye, fall at about 0.555. On the other hand the axial chromatic correction of the average eye centers at about 0.600. The mean wave length of maximum sensibility for the average photographic surface is probably also nearer 0.480 than 0.450. These considerations would indicate that a better choice for the  $P$  region may be 0.400, 0.475, 0.550 and for the  $V$  region 0.500, 0.575, 0.650.