Effect of Quality of Surface and Color upon Absorption of Light

A. L. Eustice

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Effect of Quality of Surface and Color upon Absorption of Light.

A THESIS

PRESENTED BY

Alfred L. Eustice.

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The Effect of Quality of Surface and Color upon the Absorption of Light.

The lack of information and methods for the use of artificial illuminants in economic commercial illumination prompted this investigation and study of the effect of quality of surface and color of wall coverings upon the absorption of light. The ultimate object of the investigation was to deduce a table of luminosity factors from the data thus obtained which will show the illuminating constants of the various colors with respect to white as a standard so that it will be a commercial benefit to Illuminating Engineers and of general interest to the trades.

The materials investigated, for obvious reasons, were confined to various kinds of wall papers (plain, ingrain, and crepe), tapestry burlaps and canvas, and paints. The method of procedure was quite original embracing only standard sources of light with a diffusing plate and the Weber photometer, thereby reducing many chances of errors. As Cap. Abney says:- "A serious study of color ------- must be undertaken with a clear mind, a good eye, and a fair supply of patience", and in this class of photometrical work the reliability of results depends primarily upon the personal error of the observer.

A brief review of light and the quality of surface may be of introductory interest. When a beam of light strikes any material substance one or more of three things must occur. First, the light may be reflected, as from the surface of polished silver; second

it may be transmitted through a substance, as with a transparent body like glass; third, it may be neither reflected nor transmitted, but absorbed, as in case of a substance like charcoal. With most substances these three qualities are found at the same time; the first being very useful fpr economic illumination in a wall covering and the others detrimental.

Many preliminary investigations of apparatus used in this study resulted in slight modifications of the instruments. The condition of the standard source of light demands extreme attention in order to secure accurate results. Heretofore the Weber photometer #157, was operated on a standard of amyl-acetate whose flame is a source of much error. The luminous intensity of the flame varies greatly with the degree of purity of the surrounding air diminishing in proportion to the quantity of carbonic acid gas in the air increases. The presence of the flame, moreover, gives a temperature rise which adds to the fatigue of the observer and creates small air currents through the instrument which destroy the constancy of the standard flame. Then too, the movements of the observer when balancing the instruments for a reading will cause the flame to vary in luminous intensity and its height and condition are very hard to determine. A variation in height of one mm. will introduce an error of one percent.

In order to avoid the errors thus introduced, the instrument was equipped with a miniature low voltage electric light after one suitable for photometrical purposes was obtained. Small tantalum lamps were used for the following reasons:.

First, they have an excellent color;

Second, they show a remarkable constancy in candle power after having been thoroughly seasoned;

Third, when operated under their rated voltage, owing to their positive temperature coefficient, their resistance assumes a constant value, thus making possible an accurate adjustment of the terminal voltage and hence candle power which will remain constant throughout a balance regardless of the conditions mentioned that effect a flame;

Fourth, the candle power can be regulated with precision by varying the voltage across the lamp terminals;

Fifth, the life of such a lamp was found by experiment to be long.

Considerable time was spent in securing a suitable diffusing plate which gave a true matt white surface. Experiment on papers surfaces coated with barium sulphate, plaster of paris and the like showed that a surface of plaster of paris treated with oil stone powder until the surface was true and matt gave the best surface and was a very reliable diffusing standard.

The illumination upon the standard diffusing plate of plaster of paris was secured from a thoroughly seasoned and standardized 32 candle power lamp, calibrated in the usual manner against the United States Bureau of Standards 16 candle power secondaries at their rated voltage over their terminals.

The location of the instruments was decided for general convenience and is shown diagramatically in plate #1. Referring particularly to the plate #1 wherein similar reference letters indicate like parts throughout the several settings; "A" is the standard of

illumination referred to above. It is rigidly attached to a movable arm which rotates "B" about a central point "C" and is also mounted so that the point "C" is rigid with respect to the experimental table "H". Upon the arm "B" is mounted an index pointer"D" which travels with arm "B" over the vernier "E".

The standard diffusing plate "F" and also the surface under consideration when taking data are placed in the plane of the pivot "C" supported by the stand "G" on the table "H". The surface "F" was maintained in a fixed position throughout the investigation in the plane of the center of rotation "C" and normal to the sight tube "1" of the Weber photometer.

The Weber photometer consists of a tube" 1" which is mounted horizontally and is attached to a sleeve sliding on a stout metal post screwed into the top of the containing case. The tube "1" contains a circular opal glass plate "R" which is movable by a rack and pinion operated by a milled head "U". Attached to this member is an index finger which moves over an appropriate scale"T" placed on the outside of the tube, by means of which the photometer settings are accomplished.

A lamp case slips on the larger end of the tube in which is placed the miniature tantalum standard lamp"S"; the lamp being supported by a sleeve inserted through the ventilating duct which is provided for a flame standard. The other end of tube "1" carries a sleeve upon which is centered the tube "2" whose axis is at right angles to that of tube "1". The sleeve is provided with a clamping device "P" for holding the tube at the desired angle of inclination. During this work,however, the plane was that of the horizontal.

On the interior of the tube "B" at "K" is mounted a Lummer-Brodhun contrast prism while at the smaller end "O" is located the telescopic eyepiece for viewing the optical screen "F". The eyepiece is slotted and contains a slide which has three circular openings into which are placed at "M" and "N" red and green glass respectively with the opening at "L" left blank for white. The other end of the tube is fitted with a flat and square box "J" in which various opal plates may be placed, and it is surmounted by a narrower tube "I" for the admission of the measured rays of light from the standard plane.

The photometer was maintained in a fixed position throughout the work in order to avoid the possibility of some errors, the distance between the photometer and the screen, however, is immaterial so long as the screen is well within the cone of vision of the photometer. The instruments were adjusted in position after which every precaution was observed to secure an accurate calibration.

The length of the arm "B" was chosen four feet from center of pivot to the approximate center of the standard lamp filament "A" for the following reasons:-

First, this distance permitted the use of a secondary standard of high candle power and thus materially reduce the sources of error;

Second, four feet provided a convenient distance for the physical construction of very rigid apparatus;

Third, it provided a very convenient laboratory setting;

Fourth, the distance it gave between the diffusing plate and the lamp was sufficient to reduce the effect of the uneven intensity

from the various sides of the filament to a minimum and to all purpose gave a uniform distribution about the center of the field of vision of the Weber photometer;

Fifth, the intensity of illumination thus produced gave a very good working value under nearly every color condition;

Sixth, the results obtained gave an ideal case of twofoot candles, a standard commercial value of illumination, and at the same time materially simplified the calculations.

The photometer was thoroughly cleaned and calibrated so as to be direct reading by establishing a scale of foot candles to correspond to the distance of the balancing screen "R" from the standard. The calibration was based upon the law of inverse squares by a manual setting of the screen at a given distance and balancing the instrument in the regular way, which is byvarying the distance "V" of the opal plate "R" from the standard "S" until both halves of the field of vision appear equally illuminated. In the investigations, however, the light sources (secondary)were, in many instances, of a very differentcolor so that a working comparison was made between their red and green color constituents and from these comparisons a relation was secured for expressing the illuminating power of one light source in terms of the other. This relation is given in the form of the curve as Plate #2.

The required two observations, one in red and the other in green, are secured by means of the red and green glasses in the eyepiece of the photometer. The intensity apparent by settings of the red and green are read directly from the calibration and the true intensity of illumination found by combining the intensity as shown

by the red with that of the green through a factor "K" in order to finally express the equivalent intensity of white. Expressed mathematically this statement is: "Intensity" = "R" "K" . The factor was secured from the makers table of the relations of "K" to the ratio of $\frac{\text{green}}{\text{red}}$ for the quality glass used in instrument # 157.

The data and curves herewith given show the values of the intensity of illumination and the percentage of reflecting power of the various samples for every 10 degrees of rotation of the standard light from the position giving the incident ray normal to the surface under observation.

In the data the following notation was used throughout:—

r = photometer balance in red.

g = photometer balance in green.

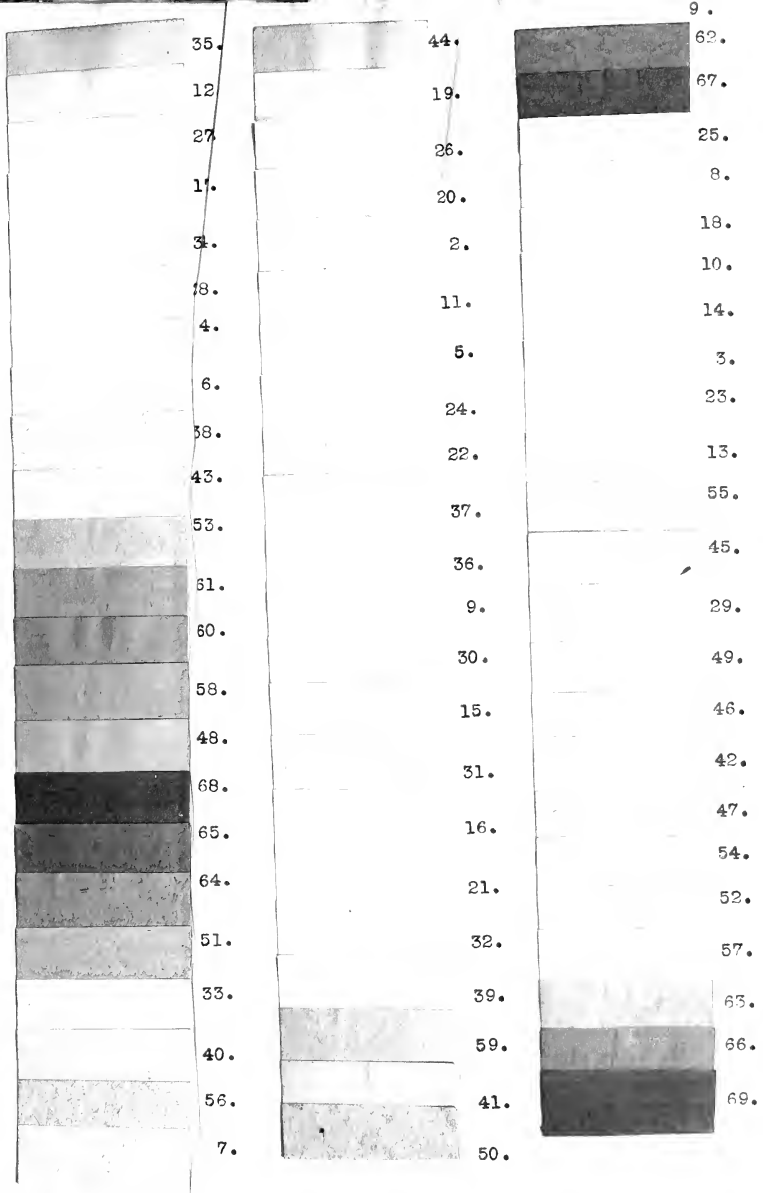
Ratio = green divided by red.

K. = corresponding value of $\frac{g}{r}$ from curve.

F.C. Ill. = true intensity of illumination in foot candles .

%Lum. = % reflecting power or luminosity.

In several cases where the percent reflecting power was comparatively small, the balances were not at all sensitive so that, since the error of such a balance would give entirely erroneous results, they were rejected and such a point of sensitiveness is indicated by the symbol * . The data, needless to say, was obtained in the photometer room where all surroundings are dull black.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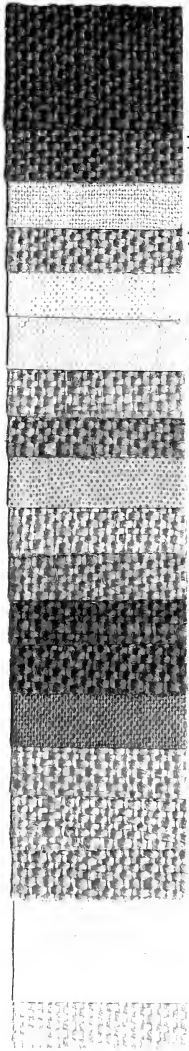
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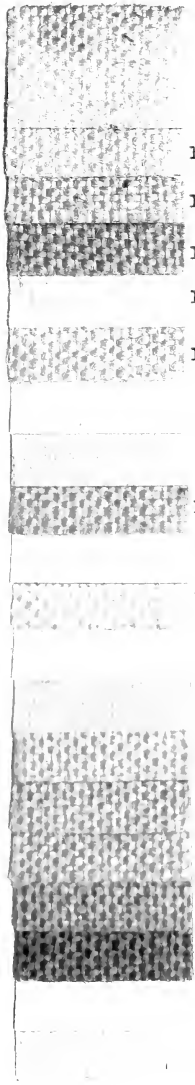
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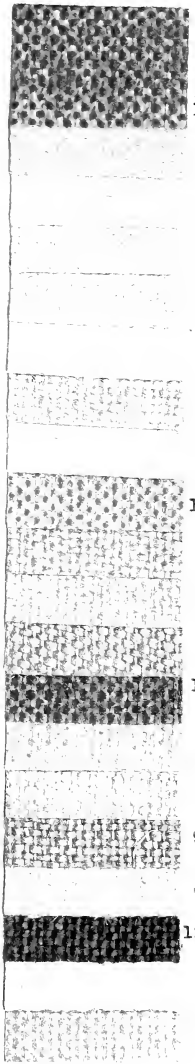
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Sample # 1.

Standard matt white surface; Plaster of Paris.

egrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	2.00	2.00	1.00	1.00	2.00	100.00
10	1.83	1.83	1.00	1.00	1.83	91.50
20	1.59	1.59	1.00	1.00	1.59	79.50
30	1.39	1.39	1.00	1.00	1.39	69.50
40	1.18	1.18	1.00	1.00	1.18	59.00
50	.936	.936	1.00	1.00	.936	46.80
60	.665	.665	1.00	1.00	.665	33.25
70	.360	.360	1.00	1.00	.360	18.00
80	.217	.217	1.00	1.00	.217	10.85

Sample # 2.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	2.00	1.94	.97	.98	1.96	98.00
10	1.83	1.64	.89	.935	1.72	86.00
20	1.64	1.505	.917	.956	1.57	78.50
30	1.54	1.31	.85	.905	1.39	69.50
40	1.36	1.18	.867	.918	1.25	62.50
50	1.03	.80	.777	.857	.883	44.15
60	.81	.70	.853	.907	.735	36.75
70	.495	.420	.847	.702	.348	17.40
80	.175	.163	.930	.961	.168	8.40

Sample # 3.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum
0	1.94	1.94	1.0	1.0	1.94	97.00
10	1.83	1.83	1.0	1.0	1.83	91.50
20	1.64	1.64	1.0	1.0	1.64	82.00
30	1.50	1.50	1.0	1.0	1.50	75.00
40	1.39	1.39	1.0	1.0	1.39	69.50
50	1.14	1.14	1.0	1.0	1.14	57.00
60	.936	.936	1.0	1.0	.936	46.80
70	.55	.55	1.0	1.0	.55	27.50
80	.253	.253	1.0	1.0	.253	12.65

Sample # 4.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.64	2.00	1.22	1.167	1.92	96.00
10	1.54	1.70	1.10	1.08	1.67	83.50
20	1.36	1.59	1.17	1.13	1.54	77.00
30	1.25	1.31	1.05	1.04	1.30	65.00
40	1.11	1.11	1.0	1.0	1.11	55.50
50	.97	1.14	1.17	1.13	1.10	55.00
60	.80	.595	.743	.832	.665	33.25
70	.485	.393	.81	.877	.425	21.25
80	.215	.237	1.1	1.08	.232	11.6

Sample #5.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.94	1.64	.845	.902	1.75	87.50
10	1.83	1.50	.82	.884	1.62	81.00
20	1.50	1.46	.973	.98	1.47	73.50
30	1.36	1.21	.89	.935	1.27	63.50
40	1.21	1.11	.917	.956	1.16	58.00
50	.99	.77	.78	.858	.85	42.50
60	.745	.52	.698	.796	.593	29.60
70	.398	.35	.88	.928	.37	18.50
80	.208	.163	.784	.860	.18	9.00

Sample # 6.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum,
0	1.41	1.83	1.30	1.22	1.72	86.00
10	1.31	1.41	1.08	1.065	1.39	69.50
20	1.21	1.25	1.03	1.027	1.24	62.00
30	1.09	1.21	1.11	1.09	1.19	59.50
40	.91	1.14	1.25	1.186	1.08	54.00
50	.73	.88	1.21	1.158	.845	42.25
60	.54	.64	1.18	1.133	.614	30.70
70	.343	.44	1.28	1.205	.414	20.70
80	.28	.235	.84	.899	.889	12.60

Sample # 7.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.50	1.70	1.13	1.105	1.66	83.00
10	1.31	1.41	1.08	1.065	1.39	69.50
20	1.14	1.33	1.16	1.125	1.28	64.00
30	.99	1.16	1.17	1.13	1.12	56.00
40	.865	1.11	1.28	1.205	1.045	52.25
50	.72	.91	1.26	1.192	.86	43.00
60	.52	.595	1.14	1.11	.577	28.85
70	.353	.402	1.14	1.11	.392	19.60
80	.202	.215	1.06	1.05	.212	10.60

Sample # 8.

Degrees.	r.	g.	Ratio.	K.	F.C.Ill.	% Lum.
0	2.00	1.46	.73	.821	1.642	82.10
10	1.83	1.39	.79	.842	1.54	77.00
20	1.64	1.31	.797	.868	1.43	71.50
30	1.415	1.16	.818	.882	1.25	62.50
40	1.332	.95	.712	.81	1.08	54.00
50	1.16	.79	.68	.783	.908	45.40
60	.865	.61	.705	.804	.695	34.75
70	.55	.31	.564	.694	.382	19.10
80	.25	.18	.72	.814	.204	10.20

Sample # 9.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.94	1.46	.752	.837	1.625	81.25
10	1.94	1.31	.675	.78	1.51	75.50
20	1.54	1.21	.785	.86	1.33	66.50
30	1.36	1.09	.801	.87	1.18	59.00
40	1.31	.99	.755	.839	1.10	55.00
50	1.07	.745	.695	.795	.85	42.50
60	.85	.46	.542	.675	.574	28.70
70	.48	.292	.608	.728	.212	10.60
80	.20	.15	.75	.836	.1672	8.36

Sample # 10.

Degrees.	r.	g.	Ratio.	K.	F.C. ILL.	% Lum.
0	1.94	1.46	.75	.836	1.62	81.00
10	1.77	1.36	.767	.85	1.51	75.50
20	1.64	1.18	.72	.814	1.34	67.00
30	1.36	1.05	.77	.85	1.16	58.00
40	1.14	.99	.87	.92	1.05	52.50
50	.90	.675	.75	.836	.753	37.65
60	.675	.455	.673	.78	.527	26.35
70	.375	.303	.81	.88	.33	16.50
80	.155	.150	.96	.98	.152	7.60

Sample# 11.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.95	1.36	.701	.802	1.56	78.00
10	1.77	1.25	.706	.806	1.43	71.50
20	1.70	1.16	.682	.784	1.34	67.00
30	1.36	1.11	.815	.880	1.20	60.00
40	1.16	.865	.745	.833	.968	48.40
50	.95	.63	.663	.770	.732	36.60
60	.62	.47	.757	.839	.52	26.00
70	.36	.235	.652	.762	.274	13.70
80	.18	.155	.86	.912	.164	8.20

Sample # 12.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.54	1.54	1.0	1.0	1.54	77.00
10	1.50	1.50	1.0	1.0	1.50	75.00
20	1.415	1.415	1.0	1.0	1.415	70.75
30	1.25	1.25	1.0	1.0	1.25	62.50
40	1.07	1.07	1.0	1.0	1.07	53.50
50	.91	.91	1.0	1.0	.91	45.50
60	.675	.675	1.0	1.0	.675	33.75
70	.402	.402	1.0	1.0	.402	20.10
80	.18	.18	1.0	1.0	.18	9.00

Sample # 13.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.83	1.36	.744	.834	1.53	76.50
10	1.59	1.18	.741	.83	1.32	66.00
20	1.36	.99	.728	.82	1.105	55.25
30	1.18	.83	.703	.803	.948	47.40
40	1.07	.62	.58	.705	.755	37.75
50	.77	.44	.572	.70	.539	26.95
60	.585	.32	.547	.68	.398	19.90
70	.275	.19	.691	.79	.217	10.85
80	.200	.14	.70	.801	.1602	8.01

Sample #14.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.83	1.36	.742	.831	1.52	76.00
10	1.64	1.28	.78	.858	1.41	70.50
20	1.39	1.01	.725	.818	1.14	57.00
30	1.25	.95	.76	.842	1.05	52.50
40	.99	.75	.76	.842	.835	41.75
50	.80	.57	.713	.81	.648	32.40
60	.54	.337	.625	.74	.40	20.00
70	.30	.22	.773	.823	.247	12.35

Sample # 15.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.83	1.36	.742	.831	1.52	76.00
10	1.77	1.31	.738	.828	1.47	73.50
20	1.59	1.14	.717	.812	1.29	64.50
30	1.39	99	.712	.809	1.13	56.50
40	1.16	.75	.646	.756	.877	43.85
50	1.01	.665	.42	.632	.775	38.75
60	.665	.42	.630	.746	.496	24.80
70	.45	.22	.686	.786	.354	17.70
80	.22	.15	.681	.783	.172	8.60

Sample # 16.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.54	1.41	.915	.974	1.47	73.50
10	1.41	1.21	.857	.91	1.28	64.00
20	1.25	1.03	.823	.886	1.11	55.50
30	1.22	.865	.710	.808	.986	49.30
40	1.07	.80	.747	.833	.892	44.60
50	.865	.69	.799	.87	.752	37.60
60	.655	.56	.855	.91	.596	29.80
70	.402	.325	.81	.877	.352	17.60
80	.209	.200	.956	.975	.204	10.20

Sample # 17.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.415	1.46	1.035	1.03	1.46	73.00
10	1.39	1.33	.957	.975	1.36	68.00
20	1.28	1.21	.945	.97	1.24	62.00
30	1.14	.97	.85	.905	1.03	51.50
40	1.01	.91	.90	.94	.95	47.50
50	.80	.73	.912	.95	.76	38.00
60.	.56	.495	.884	.93	.522	26.10
70	.37	.343	.927	.96	.356	17.80
80	.22	.195	.885	.93	.205	10.25

Sample # 18.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.70	1.332	.78	.858	1.46	73.00
10	1.505	1.18	.78	..858	1.29	64.50
20	1.46	1.14	.78	.858	1.25	62.50
30	1.415	1.11	.78	.858	1.21	60.50
40	1.28	.95	.742	.831	1.06	53.00
50	1.112	.75	.675	.781	.867	43.35
60	.79	.585	.74	.83	.656	32.80
70	.402	.262	.653	.762	.306	15.30
80	.172	.15	.871	.92	.158	7.90

Sample # 19.

Degrees.	r.	g.	Ratio.	K,,	F.C. Ill.	% Lum.
0	1.415	1.46	1.03	1.027	1.45	72.50
10	1.33	1.225	.92	.959	1.275	63.75
20	1.18	.99	..84	.899	1.06	53.00
30	.99	.90	.909	.95	.94	47.00
40	.90	.675	.75	.836	.752	37.60
50	.61	.54	.885	.93	.566	28.30
60	.445	.316	.71	;808	.36	18.00
70	.28	.26	.93	.961	.27	13.50
80	.162	.162	1.0	1.0	.162	8.10

Sample # 20.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.50	1.415	.943	.97	1.45	72.50
10	1.39	1.28	;92	.958	1.33	66.50
20	1.36	1.21	.89	.935	1.27	63.50
30	1.21	1.11	.917	.957	1.16	58.00
40	1.03	.95	.922	.958	.986	49.30
50	.90	.79	.878	.926	.834	41.70
60	.70	.595	.850	.905	.6335	31.67
70	.35	.31	.885	.931	.326	16.30
80	.155	.150	.967	.978	.152	7.60

Sample ## 21.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.77	1.25	.707	.804	1.42	71.00
10	1.64	1.21	.738	.828	1.36	68.00
20	1.50	1.16	.773	.852	1.28	64.00
30	1.41	1.09	.773	.852	1.20	60.00
40	1.31	.99	.755	.839	1.10	55.00
50	1.05	.85	.81	.877	.92	46.00
60	.85	.58	.683	.784	.668	33.40
70	.58	.375	.646	.755	.438	21.90
80	.275	.208	.755	.839	.231	11.55

Sample # 22.

Degrees,	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.64	1.28	.78	.858	1.41	70.50
10	1.39	1.07	.768	.847	1.18	59.00
20	1.31	.99	.755	.839	1.10	55.00
30	1.21	.90	.743	.831	1.005	50.25
40	1.07	.83	.775	.854	.998	49.90
50	.865	.79	.914	.954	.826	41.30
60	.64	.495	.774	.854	.547	27.35
70	.34	.26	.765	.846	.288	14.40
80	.165	.15	.907	.947	.156	7.80

Sample # 23.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.77	1.18	.667	.772	1.37	68.50
10	1.64	1.14	.695	.795	1.30	65.00
20	1.33	.97	.73	.821	1.09	54.50
30	1.31	.91	.695	.795	1.04	52.00
40	1.14	.70	.614	.734	.836	41.80
50	.97	.425	.438	.59	.572	28.60
60	.57	.325	.571	.70	.40	20.00
70	.325	.206	.635	.749	.244	12.20
80	.18					

Sample # 24.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.70	1.21	.711	.808	1.37	68.50
10	1.59	1.14	.717	.812	1.29	64.50
20	1.50	1.05	.70	.801	1.2	60.00
30	1.36	.95	.698	.798	1.09	54.50
40	1.16	;83	.715	.811	.94	47.00
50	.91	.63	.692	.792	.72	36.00
60	.595	.393	.66	.768	.457	22.85
70	.32	.245	.765	.848	.272	13.60
80	.16	.15	.937	.964	.154	7.70

Sample # 25.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.54	1.25	.812	.878	1.35	67.50
10	1.36	1.16	.852	.906	1.23	61.50
20	1.31	1.07	.816	.880	1.15	57.50
30	1.13	.936	.794	.865	1.02	51.00
40	.99	.77	.78	.858	.85	42.50
50	.81	.60	.74	.83	.672	33.60
60	.56	.398	.71	.808	.453	22.65
70	.282	.209	.741	.830	.234	11.70
80	.15*					

Sample # 26.

Degrees.	R.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.46	1.28	.876	.925	1.35	67.50
10	1.39	1.21	.868	.92	1.28	64.00
20	1.28	1.14	.89	.935	1.20	60.00
30	1.18	1.01	.855	.909	1.07	53.50
40	1.01	.90	.89	.935	.947	47.35
50	.77	.70	.908	.948	.73	36.60
60	.56	.485	.865	.918	.514	25.70
70	.356	.316	.888	.932	.332	16.60
80	.175	.155	.875	.926	.162	8.10

Sample # 27.

Degrees.	r.	g.	Ratio.	K.	F.C.Ill.	% Lum.
0	1.505	1.225	.815	.88	1.32	66.00
10	1.39	1.14	.82	.884	1.23	61.50
20	1.28	1.11	.865	.915	1.17	58.50
30	1.18	.95	.805	.874	1.03	51.50
40	1.03	.90	.873	.92	.947	47.35
50	.85	.665	.783	.86	.731	36.55
60	.62	.52	.837	.897	.556	27.80
70	.356	.29	.815	.88	.31	15.50
80	.202	.18	.891	.935	.189	9.45

Sample # 28.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.31	1.31	1.0	1.0	1.31	65.50
10	1.18	1.21	1.025	1.02	1.20	60.00
20	1.11	1.14	1.03	1.027	1.14	57.00
30	.97	1.09	1.12	1.10	1.07	53.50
40	.81	.97	1.20	1.15	.931	46.65
50	.675	.75	1.11	1.09	.736	36.80
60	.495	.495	1.0	1.0	.495	24.75
70	.303	.303	1.0	1.0	.303	15.15
80	.155	.155	1.0	1.0	.155	7.75

Sample # 29.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.64	1.11	.676	.78	1.28	64.00
10	1.46	.91	.623	.74	1.08	54.00
20	1.31	.79	.603	.722	.946	47.30
30	1.16	.70	.603	.722	.838	41.90
40	.97	.595	.613	.732	.711	35.50
50	.83	.4 5	.542	.675	.561	28.05
60	.57	.36	.631	.745	.425	21.25
70	.375	.273	.734	.823	.308	15.40
80	.213	.165	.773	.852	.182	9.10

Sample # 30.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.64	1.11	.676	.780	1.28	64.00
10	1.50	.99	.66	.768	1.06	53.00
20	1.31	.77	.587	.71	.93	46.50
30	1.09	.61	.56	.69	.752	37.60
40	.88	.485	.551	.681	.599	30.00
50	.69	.335	.497	.63	.435	21.75
60	.50	.235	.47	.618	.309	15.45
70	.292	.175	.60	.72	.21	10.50
80	.15*					

Sample # 31.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.31	1.21	.924	.96	1.26	63.00
10	1.18	1.07	.906	.947	1.12	56.00
20	1.07	.90	.84	.899	.962	48.10
30	.95	.745	.785	.86	.817	40.85
40	.75	.595	.793	.865	.65	32.50
50	.575	.512	.89	.935	.538	26.90
60	.445	.390	.876	.925	.411	20.55
70	.282	.257	.911	.950	.268	13.40
80	.17	.172	1.01	1.01	.172	8.60

Sample # 32.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.54	1.11	.72	.814	1.26	63.00
10	1.31	1.03	.786	.86	1.13	56.50
20	1.18	.81	.686	.786	.928	46.40
30	1.03	.70	.68	.783	.806	40.30
40	.83	.575	.716	.812	.674	33.70
50	.69	.53	.767	.847	.585	29.25
60	.48	.37	.771	.851	.408	20.40
70	.32	.213	.666	.772	.247	12.35
80	.15	.14	.93	.961	.144	7.20

Sample # 33.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.11	1.28	1.12	1.15	1.24	62.00
10	1.03	1.11	1.08	1.065	1.10	55.00
20	.88	1.03	1.17	1.13	.994	49.70
30	.73	.83	1.14	1.112	.812	40.60
40	.64	.69	1.08	1.065	.681	34.05
50	.505	.56	1.11	1.09	.55	27.50
60	.347	.385	1.11	1.09	.378	18.90
:70	.235	.292	1.24	1.18	.277	13.85
80	.175	.165	.94	.968	.169	8.45

Sample # 34.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.21	1.22	1.01	1.01	1.22	61.00
10	1.16	1.21	1.04	1.034	1.20	60.00
20	1.07	1.09	1.03	1.018	1.09	54.50
30	.97	.99	1.02	1.018	.988	49.40
40	.81	.865	1.07	1.058	.865	42.80
50	.60	.675	1.12	1.10	.66	33.00
60	.445	.52	1.17	1.13	.504	25.20
70	.29	.337	1.16	1.125	.326	16.30
80	.18	.19	1.06	1.05	.189	9.45

Sample # 35.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.21	1.21	1.0	1.0	1.21	60.50
10	1.18	1.18	1.0	1.0	1.18	59.00
20	1.07	1.07	1.0	1.0	1.07	53.50
30	.99	.99	1.0	1.0	.99	49.50
40	. 865	.865	1.0	1.0	.865	43;25
50	.73	.73	1.0	1.0	.73	36.50
60	.57	.57	1.0	1.0	.57	28.50
70	.393	.393	1.0	1.0	.393	19.65
80	.21	.21	1.0:	1.0	.210	10.50

Sample # 36.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.70	1.01	.582	.706	1.20	60.00
10	1.46	.90	.616	.735	1.07	53.50
20	1.39	.83	.596	.717	.995	49.75
30	1.36	.79	.58	.705	..958	47.90
40	1.18	.655	.555	.685	..76	38.00
50	1.01	.56	.555	.685	.492	24.60
60	.73	.393	.539	.673	.492	24.6
70	.512	.253	.493	.634	.325	16.25
80	.316	.195	.616	.735	.232	11.60

Sample # 37.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.70	.99	.581	.706	1.20	60.00
10	1.39	.936	.673	.789	1.09	54.50
20	1.28	.865	.675	.780	1.00	50.00
30	1.22	.80	.655	.764	.93	46.50
40	1.11	.655	.59	.716	.795	39.75
50	.88	.505	.575	.702	.619	30.95
60	.62	.343	.533	.683	.423	21.15
70	.416	.215	.517	.653	.272	13.60
80	.197*					

Sample # 38.

Degrees.	R,	g.	Ratio.	K.	F.C.Ill.	% Lum.
0	1.21	1.18	.976	.984	1.19	59.50
10	1.14	1.09	.955	.974	1.11	55.50
20	1.05	1.01	.961	.977	1.025	51.25
30	.95	.97	1.02	1.018	.965	48.25
40	.73	.91	1.24	1.18	.861	43.05
50	.64	.80	1.25	1.186	.76	38.00
60	.393	.550	1.40	1.28	.503	25.15
70	.26	.297	1.14	1.112	.289	14.45
80	.17	.18	1.06	1.05	.178	8.90

Sample # 39.

Degrees.	r.	G.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.25	1.11	.888	.932	1.17	58.50
10	1.18	1.01	.847	.902	1.065	53.25
20	1.05	.81	.77	.95	.893	44.65
30	.90	.63	.70	.801	.72	36.00
40	.73	.512	.70	.801	.585	29.25
50	.595	.44	.74	.83	.495	24.75
60	.425	.31	.73	;821	.35	17.50
70	.247	.215	.865	.917	.226	11.30
80	.153*					

Sample # 40.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.97	1.18	1.22	1.167	1.13	56.50
10	.88	1.09	1.24	1.18	1.04	52.00
20	.745	.90	1.21	1.158	.862	43.10
30	.64	.85	1.32	1.231	.79	39.50
40	.54	.72	1.33	1.239	.67	33.50
50	.38	.495	1.3	1.22	.464	23.20
60	.292	.36	1.23	1.172	.342	17.10
70	.208	.26	1.25	1.186	.246	12.30
80	.15*					

Sample # 41.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.28	1.03	.805	.875	1.12	56.00
10	1.25	.936	.75	.836	1;05	52.50
20	1.03	.77	.746	.834	.86	43.00
30	.936	.69	.736	.827	.772	38.60
40	.81	.57	.703	.803	.65	32.50
50	.63	.455	.722	.816	.514	25.70
60	.50	.310	.62	.737	.3685	18.42
70	.325	.212	.652	.761	.247	12.35
80	.175	.155	.885	.931	.163	8.15

Sample #42.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.415	.95	.671	.779	1.105	55.25
10	1.28	.80	.625	.741	.95	47.50
20	1.18	.69	.585	.708	.836	41.80
30	.95	.512	.538	.672	.638	31.90
40	.75	.347	.463	.613	.46	23.00
50	.575	.294	.512	.651	.374	18.70
60	.440	.215	.489	.632	.278	13.90
70	.235	.175	.745	.833	.196	9.80
80	. *					

Sample #43.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.936	1.09	1.16	1.12	1.05	52.50
10	.865	1.05	1.21	1.16	1.01	50.50
20	.745	.95	1.27	1.20	.895	44.75
30	.64	.865	1.36	1.26	.807	40.35
40	.512	.62	1.21	1.16	.593	29.65
50	.44	.48	1.09	1.07	.471	23.55
60	.292	.36	1.23	1.17	.342	17.10
70	.190	.235	1.24	1.18	.224	11.20
80	.15	.17	1.13	1.11	.166	8.30

Sample # 44.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.07	1.01	.945	.97	1.04	52.00
10	1.01	1.01	1.0	1.0	1.01	50.50
20	.98	1.01	1.15	1.12	.986	49.30
30	.80	.99	1.23	1.17	.936	46.80
40	.665	.77	1.16	1.12	.745	37.25
50	.595	.655	1.10	1.08	.642	32.10
60	.455	.54	1.18	1.14	.519	25.85
70	.29	.36	1.24	1.18	.342	17.10
80	.177	.20	1.13	1.105	.196	9.80

Sample # 45.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.39	.80	.575	.702	.975	48.75
10	1.14	.70	.613	.732	.835	41.75
20	1.03	.54	.523	.661	.68	34.00
30	.90	.38	.422	.577	.519	25.95
40	.83	.343	.413	.572	.475	23.75
50	.69	.292	.422	.577	.398	19.90
60	.455	.213	.468	.616	.280	14.00
70	.27	.173	.64	.75	.203	10.15
80	.15*					

Sample #46.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.36	.80	.588	.71	.966	48.30
10	1.22	.69	.565	.695	.848	42.40
20	1.05	.595	.566	.695	.730	36.50
30	.97	.47	.485	.629	.61	30.50
40	.73	.398	.545	.678	.495	24.75
50	.56	.32	.571	.70	.392	19.60
60	.393	.245	.623	.74	.291	14.55
70	.215	.155	.72	.814	.175	8.75
80	.15*					

Sample # 47.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.31	.81	.618	.736	.965	48.25
10	1.07	.72	.673	.78	.835	41.75
20	.97	.62	.638	.749	.734	36.70
30	.81	.52	.642	.752	.609	30.45
40	.78	.54	.613	.731	.571	28.55
50	.77	.41	.532	.666	.508	25.40
60	.55	.335	.619	.73	.402	20.10
70	.303	.245	.807	.875	.265	13.25
80	.163	.14	.858	.91	.148	7.40

Sample # 48.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.770	.90	1.17	1.13	.87	43.50
10	.62	.665	1.07	1.058	.655	32.75
20	.52	.52	1.0	1.0	.52	26.00
30	.425	.455	1.07	1.058	.45	22.50
40	.33	.38	1.15	1.12	.37	18.50
50	.262	.303	1.15	1.12	.294	14.70
60	.218	.22	1.01	1.01	.22	11.00
70	.168*					
80	.150*					

Sample # 49.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.28	.69	.54	.674	.862	43.10
10	1.14	.595	.521	.660	.753	36.75
20	.99	.48	.49	.632	.626	31.30
30	.88	.343	.39	.652	.487	24.35
40	.655	.272	.415	.573	.376	18.80
50	.54	.235	.436	.589	.318	15.90
60	.385	.206	.535	.670	.258	12.90
70	.230	.175	.76	.842	.193	9.65
80*						

Sample # 50.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.936	.73	.78	.858	.803	40.15
10	.901	.56	.622	.739	.666	33.30
20	.83	.48	.578	.702	.582	29.10
30	.69	.45	.652	.761	.525	26.25
40	.57	.36	.631	.746	.425	21.25
50	.46	.262	.57	..699	.322	16.10
60	.356	.225	.632	.746	.266	13.30
70	.245	.170	.693	.793	.195	9.75
80	.15*					

Sample # 51.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.675	.81	1.20	1.15	.776	38.80
10	.595	.77	1.31	1.225	.716	35.80
20	.55	.64	1.16	1.125	.618	30.90
30	.502	.62	1.23	1.172	.588	29.40
40	.48	.56	1.16	1.125	.540	27.00
50	.347	.52	1.50	1.34	.464	23.20
60	.316	.316	1.0	1.0	..316	15.80
70	.225	.225	1.0	1.0	.225	11.26
80	.140	.140	1.0	1.0	.140	7.00

Sample # 52.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.39	.52	.374	.543	.756	37.80
10	1.33	.44	.331	.519	.69	34.50
20	1.21	.333	.276	.48	.581	29.55
30	1.18	.310	.263	.47	.555	27.75
40	.936	.225	.249	.452	.423	21.15
50	.75	.190	.252	.462	.347	17.35
60	.56	.175	.313	.507	.284	14.20
70	.31	.15	.483	.627	.194	9.70
80	.195*					

Sample # 53.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	.73	.75	1.03	1.027	.749	37.45
10	.57	.73	1.28	1.205	.686	34.30
20	.485	.70	1.44	1.304	.632	31.60
30	.385	.495	1.28	1.205	.464	23.20
40	.313	.402	1.28	1.205	.377	18.85
50	.250	.347	1.38	1.270	.318	15.90
60	.202	.267	1.32	1.231	.249	12.45
70	.180	.209	1.16	1.125	.202	10.10
80	*					

Sample # 54.

Degrees.	r.	g,	Ratio.	K.	F.C. Ill.	% Lum.
0	1.18	.550	.466	.616	.726	36.30
10	1.05	.505	.480	.625	.655	32.75
20	.95	.38	.40	.56	.532	26.60
30	.81	.325	.401	.561	.455	22.75
40	.69	.278	.404	.564	.388	19.40
50	.585	.235	.404	.564	.332	16.60
60	.375	.184	.480	.625	.235	11.75
70	.242	.155	.64	.75	.182	9.10
80	.15*					

Sample # 55.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.09	.56	.513	.653	.713	35.75
10	.95	.54	.568	.697	.662	33.10
20	.90	.416	.463	.613	.552	27.60
30	.80	.335	.419	.574	.458	22.90
40	.73	.294	.402	.562	.414	20.70
50	.61	.278	.456	.606	.37	18.50
60	.48	.215	.447	.597	.287	14.35
70	.288	.170	.59	.712	.205	10. 25
80	.190*					

Sample # 56.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.69	.72	1.04	1.034	.714	35.70
10	.65	.665	1.05	1.04	.655	32.75
20	.575	.595	1.03	1.027	.591	29.55
30	.45	.52	1.15	1.12	.504	25;20
40	.36	.46	1.28	1.205	.434	21.70
50	.297	.316	1.06	1.05	.312	15.60
60	.265	.282	1.06	1.05	.279	13.95
70	.190	.220	1.16	1.125	.214	10.70
80	.149	.160	1.14	1.112	.156	7.80

Sample # 57.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.54	.41	.266	.462	.712	35.60
10	1.54	.36	.234	.45	.693	34.65
20	1.39	.28	.202	.425	.591	29.55
30	1.22	.257	.210	.432	.528	26.40
40	1.03	.190	.184	.412	.425	21.25
50	.81	.175	.216	.437	.356	17.80
60	.57	.15	.263	.461	.263	13.15
70	.282*					

Sample # 58.

Degrees,	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.595	.73	1.230	1.172	.697	34.85
10	..512	.495	.966	.978	.502	25.10
20	.440	.480	1.09	1.09	.461	23.05
30	.356	.425	1.19	1.145	.407	20.35
40	.290	.416	1.43	1.30	.377	18.85
50	.230	.282	1.22	1.167	.268	13.40
60	.20	.24	1.20	1.15	.230	11.50
70	.165	.190	1.17	1.13	.187	9.35
80	*					

Sample # 59.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.88.	.610	.693	.790	.695	34.75
10	.81	.570	.703	.80	.648	32.40
20	.745	.550	.737	.830	.619	30.95
30	.61	.402	.66	.77	.470	23.50
40	.52	.337	.647	.755	.393	19.65
50	.425	.288	.676	.780	.332	16.60
60	.33	.235	.71	.81	.267	13.35
70	.225	.175	.776	.856	.193	9.65
80	.155	.140	.902	.94	.146	7.30

Sample # 60.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	.530	.655	1.23	1.172	.621	31.05
10	.402	.495	1.23	1.172	.472	23.60
20	.330	.440	1.33	1.240	.410	20.50
30	.28	.36	1.28	1.205	.338	16.90
40	.213	.310	1.45	1.310	.280	14.00
50	.195	.235	1.21	1.158	.226	11.30
60	.170	.210	1.23	1.172	.199	9.95
70	.150*					
80	.00*					

Sample # 61.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.393	.730	1.855	1.54	.606	30.30
10	.350	.520	1.48	1.33	.466	23.30
20	.260	.41	1.58	1.39	.362	18.10
30	.225	.325	1.44	1.304	.294	14.70
40	.187	.270	1.44	1.3044	.244	12.20
50	.175	.240	1.37	1.263	.221	11.05
60	.150	.215	1.43	1.30	.195	9.75
70	*					

Sample # 62.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.70	.495	.708	.806	.564	28.20
10	.61	.393	.643	.753	.459	22.95
20	.575	.365	.635	.747	.429	21.45
30	.45	.294	.653	.762	.343	17.15
40	.402	.260	.647	.757	.304	15.20
50	.353	.209	.591	.712	.252	12.60
60	.282	.175	.620	.737	.208	10.40
70	.209	.150	.717	.811	.170	8.50
80	.15*					

Sample # 63.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.14	.310	.262	.470	.535	26.75
10	1.09	.292	.268	.473	.516	25.80
20	1.03	.204	.198	.424	.436	21.80
30	.90	.204	.195	.422	.380	19.00
40	.73	.112	.154	.392	.287	14.35
50	.53	.089	.168	.402	.213	10.65
60	.416	.063	.151	.391	.162	8.10
70	.173	.055	.312	.507	.0878	4.39
80	*					

Sample # 64.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.375	.64	1.71	1.46	.547	27.35
10	.33	.57	1.73	1.47	.485	24.25
20	.25	.50	2.00	1.61	.402	20.10
30	.225	.44	1.95	1.585	.357	17.85
40	.20	.33	1.65	1.42	.282	12.40
50	.18	.282	1.56	1.38	.248	12.40
60	.15	.215	1.43	1.30	.195	9.75
70	*					

Sample # 65.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.33	.485	1.47	1.322	.447	22.35
10	.278	.450	1.62	1.412	.393	19.65
20	.235	.42	1.78	1.50	.352	17.60
30	.200	.343	1.71	1.463	.293	14.60
40	.188	.282	1.50	1.34	.252	12.60
50	.150	.200	1.33	1.24	.186	9.30
60	.105	.165	1.57	1.38	.145	7.25
70	*	.079*				

Sample # 66.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.830	.220	.265	.472	.392	19.60
10	.745	.198	.266	.472	.353	17.65
20	.730	.185	.245	.465	.340	17.00
30	.550	.170	.310	.505	.278	13.90
40	.272	.104	.393	.553	.150	7.50
50	.231	.089	.386	.550	.127	6.35
60	.150	.059	.392	.553	.083	4.15
70	*					

Sample # 67.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.47	.282	.60	.72	.338	16.90
10	.44	.220	.50	.64	.282	14.10
20	.393	.209	.532	.667	.262	13.10
30	.347	.199	.573	.702	.244	12.20
40	.310	.170	..548	.678	.210	10.50
50	.255	.150	.588	.710	.181	9.05
60	.213	.120	.563	.693	.148	7.40
70	.180	.111	.615	.734	.132	6.60
80	.160 *					

Sample # 68.

0	.575	.196	.341	.526	.303	15.25
10	.540	.190	.352	.531	.287	14.35
30	.460	.175	.380	.548	.252	12.60

Sample # 69.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.215	.310	1.44	1.304	.281	14.05
10	.213	.270	1.27	1.20	.256	12.80
20	.202	.214	1.06	1.05	.212	10.60
30	.180	.208	1.15	1.12	.202	10.10
40	.173	.192	1.11	1.09	.188	9.40
50	.100	.150	1.34	1.34	.136	6.70
60	.085	.100	1.17	1.13	.096	4.80
70	.07	.083	1.18	1.14	.080	4.00
80	*					

Sample # 70.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.59	1.59	1.0	1.0	1.59	79.50
10	1.54	1.54	1.0	1.0	1.54	77.00
20	1.46	1.46	1.0	1.0	1.46	73.00
30	1.25	1.25	1.0	1.0	1.25	62.50
40	1.11	1.11	1.0	1.0	1.11	55.50
50	.95	.95	1.0	1.0	.95	47.50
60	.63	.63	1.0	1.0	.63	31.50
70	.33	.33	1.00	1.0	.33	16.50
80	.185	.185	1.0	1.0	.185	9.25

Sample # 71.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.415	1.28	.904	.944	1.34	67.00
10	1.31	1.11	.847	.903	1.18	59.00
20	1.18	1.07	.907	.947	1.12	56.00
30	1.05	.95	.905	.945	.992	49.60
40	.865	.70	.808	.876	.758	37.90
50	.73	.655	.896	.938	.685	34.25
60	.55	.425	.772	.852	.469	23.45
70	.292	.252	.863	.914	.267	13.35
80	.153	.150	..980	.987	.151	7.55

Sample # 72.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.46	1.22	.835	.896	1.31	65.50
10	1.33	1.14	.850	.905	1.20	60.00
20	1.22	1.05	.860	.912	1.11	55.50
30	1.18	.99	.84	.899	1.06	53.00
40	1.01	.91	.90	.94	.95	47.50
50	.810	.730	.901	.941	.762	38.10
60	.630	.57	.904	.944	.595	29.75
70	.375	.330	.880	.928	.348	17.40
80	.175	.163	.931	.961	.168	8.40

Sample # 73.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	%Lum.
0	1.54	1.18	.765	.846	1.305	65.25
10	1.33	1.05	.789	.863	1.15	57.50
20	1.31	1.03	.789	.863	1.13	56.50
30	1.22	.95	.778	.857	1.05	52.50
40	1.11	.75	.676	.781	.867	43.35
50	.85	.655	.770	.850	.721	36.05
60	.610	.460	.754	.838	.512	25.60
70	.420	.356	.847	.903	.379	18.95
80	.195	.157	.805	.874	.171	8.55

Sample # 74.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.36	1.11	.815	.881	1.20	60.00
10	1.25	1.03	.823	.886	1;11	55.50
20	1.18	.95	.805	.874	1.03	51.50
30	1.07	.80	.747	.833	.892	44.60
40	.936	.70	.748	.835	.782	39.10
50	.730	.505	.691	.791	.578	28.90
60	.550	.385	.700	.801	.441	22.05
70	.292	.220	.752	.837	.244	12.20
80	.15*					

Sample # 75.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.31	.990	.755	.839	1.10	55.00
10	1.28	.91	.71	.808	1.03	51.50
20	1.25	.90	.72	.814	1.02	51.00
30	1.11	.770	.666	.774	.859	42.95
40	.95	.655	.690	.790	.751	37.55
50	.745	.595	.798	.86[illegible]	.647	32.35
60	.585	.385	.657	.765	.448	22.40
70	.36	.268	.738	.828	.298	14.90
80	.180	.150	.833	.894	.161	8.05

Sample # 76.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.07	1.03	.962	.978	1.05	52.50
10	1.18	.90	.762	.843	.995	49.75
20	1.14	.865	.760	.842	.96	48.00
30	1.14	.81	.71	.808	.922	46.10
40	.99	.81	.82	.884	.875	43.75
50	.81	.512	.632	.746	.605	30.25
60	.63	.42	.666	.774	.488	24.20
70	.43	.282	.655	.764	.329	16.45
80	.165	.155	.939	.968	.160	8.00

Sample # 77.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.936	1.03	1.1	1.08	1.01	50.50
10	.85	.936	1.1	1.08	.917	45.85
20	.70	.85	1.21	1.158	.810	40.50
30	.59	.655	1.11	1.09	.643	32.15
40	.47	.585	1.24	1.18	.555	27.75
50	.39	.44	1.13	1.105	.431	21.55
60	.267	.294	1.1	1.108	.288	14.40
70	.175	.199	1.14	1.112	.194	9.70
80	*					

Sample # 78.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.11	.936	.843	.902	1.00	50.00
10	.99	.745	.753	.838	.830	41.50
20	.936	.790	.844	.902	.843	42.15
30	.655	.620	.946	.970	.636	31.80
40	.585	.485	.829	.892	.522	26.10
50	.380	.343	.902	.942	.358	17.90
60	.290	.258	.890	.935	.271	13.55
70	.204	.190	.931	.961	.196	9.80
80	*					

Sample # 79.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.16	.91	.784	.860	.997	49.85
10	1.09	.77	.705	.805	.877	43.85
20	1.07	.72	.672	.779	.833	41.65
30	1.01	.630	.623	.739	.746	37.30
40	.79	.57	.722	.816	.645	32.25
50	.70	.485	.693	.793	.555	27.75
60	.45	.306	.680	.783	.352	17.60
70	.303	.215	.710	.808	.245	12.25
80	.178	.163	.915	.954	.170	8.50

Sample #80.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill	% Lum.
0	1.09	.88	.807	.875	.953	47.65
10	1.03	.80	.776	.856	.882	44.10
20	.990	.70	.710	.808	.799	39.95
30	.865	.610	.705	.805	.696	34.80
40	.790	.55	.695	.795	.628	31.40
50	.600	.44	.733	.824	.494	24.70
60	.460	.36	.783	.860	.396	19.80
70	.282	.215	.763	.845	.238	11.90
80	.175	.155	.885	.931	.163	8.15

Sample # 81.

Degrees.	r.	g.	Ratio.	K,	F.C. Ill.	% Lum.
0	1.09	.88	.807	.875	.952	47.60
10	1.01	.80	.792	.864	.871	43.55
20	.95	.69	.726	.818	.777	38.85
30	.865	.54	.624	.740	.64	32.00
40	.70	.505	.721	.814	.57	28.50
50	.62	.402	.648	.758	.471	23.55
60	.495	.33	.667	.775	.384	19.20
70	.343	.257	.75	.836	.287	14.35
80	.183	.163	.891	.935	.171	8.55

Sample # 82.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.85	.97	1.14	1.112	.945	47.25
10	.77	.88	1.14	1.112	.856	42.80
20	.64	.80	1.25	1.186	.758	37.90
30	.50	.585	1.17	1.130	.565	28.25
40	.39	.445	1.14	1.110	.433	21.65
50	.29	.347	1.19	1.145	.332	16.60
60	.21	.257	1.22	1.167	.245	12.25
70	.158	.186	1.17	1.13	.178	8.90
80	*					

Sample # 83..

Degrees.	r.	g.	Ratio.	k.	F.C. Ill.	% Lum.
0	.75	.936	1.25	1.186	.89	44;50
10	.675	.85	1.26	1.192	.804	40.20
20	.56	.675	1.20	1.15	.644	32.20
30	.44	.595	1.35	1;25	.550	27.50
40	.33	.450	1.36	1.256	.414	20.70
50	.27	.375	1.39	1.275	.344	17.20
60	.207	.257	1.24	1.18	.245	12.25
70	.150	.190	1.26	1.192	.179	8.95
80	*					

Sample # 84.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.90	.85	.945	.97	.873	43.65
10	.83	.75	.904	.944	.783	39.15
20	.73	.63	.862	.914	.667	33.35
30	.63	.50	.794	.866	.546	27.30
40	.512	.416	.813	.879	.450	22.50
50	.402	.33	.821	.885	.356	17.80
60	.265	.215	.812	.878	.235	11.75
70	.185	.150	.812	.878	.162	8.10
80	.166*					

Sample # 85.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.14	.73	.64	.75	.855	42.75
10	1.09	.675	.619	.736	.802	40.10
20	.95	.57	.600	.72	.684	34.20
30	.90	.55	.612	.731	.658	32.90
40	.70	.343	..490	.632	.442	22.10
50	.53	.310	..585	.709	.376	18.80
60	.398	.228	.573	.601	.239	11.95
70	.282	.180	.639	.750	.211	10.55
80	.15 *					

Sample #86.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.97	.745	.768	.848	.822	41.10
10	.95	.620	.653	.762	.723	36.15
20	.85	.505	.594	.715	.608	30.40
30	.75	.440	.586	.709	.532	26.60
40	.63	.410	.65	.76	.478	23.90
50	.50	.330	.66	.768	.384	19.20
60	.375	.258	.698	.789	.296	14.80
70	.245	.190	.775	.854	.209	10.45
80	*	*				

Sample # 87.

Degrees.	r.	g.	Ratio.	k.	F.C. Ill.	% Lum.
0	1.25	.64	.512	.652	.815	40.75
10	1.225	.48	.392	.553	.667	33.85
20	1.16	.385	.332	.519	.602	30.10
30	1.09	.440	.403	.563	.614	30.70
40	.936	.455	.486	.629	.588	29.40
50	.810	.294	.363	.537	.436	21.80
60	.55	.215	.391	.553	.304	15.20
70	.32	.175	.547	.678	.217	10.85
80	.15 *					

Sample # 88.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.204	.290	.142	.384	.783	39.15
10	.181	.247	.136	.381	.690	34.50
20	.164	.237	.144	.388	.637	31.85
30	.150	.209	.140	.383	.574	28.70
40	.140	.195	.139	.382	.535	26.75
50	*	.190				
60	*	.163				
70	*	.145*				
80	*	*				

Sample # 89.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.70	.80	1.14	1.11	.777	38.85
10	.63	.75	1.19	1.145	.722	36.10
20	.595	.68	1.14	1.11	.66	33.00
30	.495	.675	1.36	1.256	.621	31.05
40	.42	.600	1.43	1.30	.546	27.30
50	.375	.46	1.23	1.17	.449	22.45
60	.292	.375	1.28	1.205	.352	17.60
70	.195	.240	1.23	1.17	.228	11.40
80	.150*	*				

Sample # 90.

Degrees.	r,	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.85	.73	.86	.912	.775	38.75
10	.79	.62	.947	.960	.682	34.05
20	.69	.64	.927	.960	.662	33.10
30	.655	.53	.810	.877	..575	28.75
40	.595	.450	.756	.840	.500	25.00
50	.48	.430	.895	.937	.450	22.50
60	.390	.294	.753	.838	.327	16.35
70	.267	.220	.823	.986	.237	11.85
80	.171	.163	.953	.974	.167	8.35

Sample # 91.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.05	.595	.566	.696	.731	36.55
10	.936	.560	.598	.719	.674	33.70
20	.90	.480	.533	.668	.602	30.10
30	.80	.425	.531	.666	.533	26.65
40	.72	.35	.485	.629	.453	22.65
50	.485	.224	.461	.611	.297	14.85
60	.402	.209	.520	.659	.265	13.25
70	.268	.156	.582	.707	.189	9.45
80	.170*	*				

Sample # 92.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum,
0	1.18	.54	.457	.607	.716	35.80
10	1.11	.52	.468	.617	.685	34.25
20	1.09	.505	.463	.613	.668	33.40
30	.99	.393	.397	.558	.553	27.65
40	.83	.333	.401	.561	.466	23.30
50	.64	.258	.403	.563	.361	18.05
60	.47	.204	.434	.587	.276	13.80
70	.31	.156	.503	.643	..200	10.00
80	*					

Sample # 93.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.83	.655	.788	.861	.714	35.70
10	.77	.64	.83	.892	.687	34.35
20	.69	.60	.87	.92	.636	31.80
30	.575	.56	.973	.982	.565	28.25
40	.44	.42	.955	.975	.428	21.40
50	.35	.337	.962	.978	.342	17.10
60	.25	.228	.912	.951	.238	11.90
70	.165	.156	.945	.970	.160	8.00
80	*					

Sample #94.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.57	.77	1.35	1.25	.712	35.60
10	.55	.64	1.16	1.125	.618	30.90
20	.57	.50	.877	.927	.528	26.40
30	.46	.57	1.24	1.18	.42	27.10
40	.337	.40	1.19	1.145	.386	19.30
50	.257	.310	1.20	1.150	.296	14.80
60	.20	.215	1.07	1.058	.214	10.58
70	.15	.165	1.10	1.08	.162	8.10
80	*	*				

Sample # 95.

Degrees.	r.	g.	Ratio.	k.	F.C. Ill.	% Lum.
0	.54	.77	1.42	1.30	.702	35.10
10	.45	.64	1.42	1.30	.586	29.30
20	.41	.610	1.48	1.33	.546	27.30
30	.393	.570	1.45	1.31	.515	25.75
40	.31	.52	1.68	1.446	.448	22.40
50	.282	.402	1.42	1.29	.364	18.20
60	.207	.310	1.49	1.33	.276	13.80
70	.173	.209	1.20	1.158	.201	10.05
80	*	.145*				

Sample # 96.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.14	.495	.434	.587	.670	33.50
10	1.09	.440	.403	.563	.614	30.70
20	1.07	.393	.367	.538	.576	28.80
30	.91	.365	.401	.561	.512	25.60
40	.81	.294	.363	.537	.435	21.75
50	.655	.245	.374	.544	.356	17.80
60	.50	.199	.398	.559	.2795	13.97
70	.306	.156	.509	.649	.199	9.95
80	.20	*				

Sample # 97.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.865	.540	.624	.741	.641	32.05
10	.830	.40	.482	.626	.520	26.00
20	.70	.37	.514	.654	.457	22.85
30	.61.	.294	.482	.626	.382	19.10
40	.585	.270	.461	.611	.357	17.85
50	.445	.204	.458	.608	.271	13.55
60	.337	.175	.518	.658	..222	11.10
70	.240	.150	.623	.739	.177	8.85
80	.15*	*				

Sample # 98.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.25	.37	.296	.495	.619	30.95
10	1.18	.335	.284	.484	.57	28.50
20	1.09	.288	.264	.471	.513	25.65
30	.865	.212	.245	.455	.394	19.70
40	.72	.175	.243	.454	.327	16.35
50	.52*	*				
60	.353*	*				
70	.22*	*				
80	.145*	*				

Sample # 99.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.540	.630	1.16	1.125	.608	30.40
10	.500	.585	1.17	1.130	.565	28.25
20	.430	.505	1.17	1.13	.486	24.30
30	.360	.45	1.24	1.186	.427	21.35
40	.310	.375	1.21	1.158	.358	17.90
50	.275	.303	1.10	1.08	.297	14.85
60	.215	;230	1.07	1.058	.228	11.40
70	.170	.180	1.06	1.05	.178	8.90
80	*	*				

Sample # 100.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.70	.54	.772	.852	.596	29.80
10	.665	.393	.590	.712	.472	23.60
20	.570	.343	.602	.721	.411	20.55
30	.480	.297	.618	.736	.354	17.70
40	.440	.235	.533	.668	.294	14.70
50	.360	.209	.580	.705	.254	12.70
60	.267	.170	.636	.748	.200	10.00
70	.202	.150	.743	.832	.168	8.40
80	.150*	*				

Sample # 101.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.79	.505	.639	.750	.593	29.65
10	.72	.470	.653	.763	.550	27.50
20	.655	.440	.672	.779	.511	25.50
30	.595	.425	.714	.811	.483	24.15
40	.505	.385	.763	.834	.426	21.30
50	.440	.292	.663	.771	.339	16.95
60	.294	.237	.806	.875	..257	12.85
70	.200	.175	.875	.924	.185	9.25
80	*	*				

Sample #102.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.450	.620	1.38	1.27	.571	28.85
10	.425	.54	1.27	1.20	.51	25.50
20	.402	.45	1.12	1.10	.442	22.10
30	.390	.410	1.05	1.04	.405	20.25
40	.340	.353	1.04	1.034	.352	17.60
50	.290	.343	1.18	1.138	.330	16.50
60	.228	.228	1.0	1.0	.228	11.40
70	.156	.176	1.13	1.105	.172	8.60
80	*	*				

Sample # 103.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.745	.48	.644	.754	.562	28.10
10	.720	.45	.625	.741	.534	26.70
20	.69	.425	.616	.734	.507	25.35
30	.585	.330	.563	.693	.406	20.30
40	.402	.225	.560	.690	.277	13.85
50	.306	.185	.604	.724	.222	11.10
60	.237	.173	.729	.820	.194	9.70
70	.166*	*				
80	.*					

Sample # 104.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.390	.595	1.52	1.35	.526	26.30
10	.365	.530	1.45	1.31	.478	23.90
20	.347	.43	1.24	1.18	.409	20.45
30	.340	.402	1.18	1.138	.387	19.35
40	.280	.356	1.27	1.20	.336	16.80
50	.229	.330	1.44	1.304	.299	14.95
60	.195	.245	1.26	1.192	.232	11.60
70	.155	.180	1.16	1.125	.175	8.75
80	*	.150 *				

Sample # 105.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.690	.410	.594	.715	.494	24.70
10	.610	.385	.631	.747	.455	22.75
20	.595	.337	.566	.696	.414	20.70
30	.540	.310	.573	.701	.379	18.95
40	.460	.270	.587	.789	.326	16.30
50	.360	.223	.619	.736	.265	13.25
60	.288	.185	.641	.751	.216	10.80
70	.204	.150	.735	.826	.168	8.40
80	.15 *	*				

Sample #106.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.990	.294	.297	.496	.491	24.55
10	.936	.235	.251	.462	.433	21.65
20	.880	.257	.292	.492	.432	21.60
30	.750	.225	.300	.50	.375	18.75
40	.690	.195	.282	.483	.333	16.65
50	.52	.18	.346	.528	.285	14.25
60	.41	.163	.397	.558	.229	11.45
70	.230*	*				
80	.150*	*				

Sample # 107.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.278	.310	1.110	1.09	.490	24.50
10	.257	.285	1.110	1.09	.468	23.40
20	.235	.267	1.14	1.112	.261	13.50
30	.220	.214	.973	.982	.216	10.80
40	.197	.209	1.06	1.05	.207	10.35
50	.175	.184	1.04	1.034	.181	9.05
60	.152	.163	1.07	1.058	.161	8.05
70	*					
80	*					

Sample #108.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.46	.495	1.07	1.058	.486	24.30
10	.450	.460	1.02	1.018	.458	22.90
20	.41	.42	1.02	1.018	.417	20.85
30	.385	.385	1.0	1.0	.385	19.25
40	.330	.330	1.0	1.0	.330	16.50
50	.267	.267	1.0	1.0	.267	13.35
60	.202	.202	1.0	1.0	.202	10.10
70	.163	.163	1.0	1.0	.163	8.15
80	*					

Sample # 109.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.45	.45	1.0	1.0	.45	22.50
10	.43	.43	1.0	1.0	.43	21.50
20	.402	.402	1.0	1.0	.402	20.10
30	.380	.380	1.0	1.0	.380	19.00
40	.333	.333	1.0	1.0	.333	16.65
50	.263	.263	1.0	1.0	.263	13.15
60	.213	.213	1.0	1.0	.213	10.65
70	.171	.171	1.0	1.0	.171	8.55
80	*					

Sample # 110.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.585	.353	.604	.724	.424	21.20
10	.540	.353	.654	.764	.413	20.65
20	.505	.294	.581	.706	.357	17.85
30	.450	.270	.600	.720	.324	16.20
40	.375	.250	.676	.781	.293	14.65
50	.300	.215	.716	.811	.243	12.15
60	.257	.16[illegible]	.645	.755	;194	9.70
70	.173 *					
80	*					

Sample # 111.

Degrees.	r.	G,	Ratio.	K.	F.C. Ill.	% Lum.
0	1.01	.178	.410	.410	.413	20.65
10	.88	.163	.185	.414	.365	18.25
20	.83	.150	.181	.412	.342	17.10
30	* *	**				

Sample # 112.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.360	.385	1.07	1.058	.381	19.05
10	.353	.330	.935	.965	.344	17.20
20	.310	.310	1.0	1.0	.310	15.50
30	.297	.297	1.0	1.0	.297	14.85
40	.282	.282	1.0	1.0	.282	14.10
50	.215	.215	1.0	1.0	.215	10.75
60	.175	.175	1.0	1.0	.175	8.75
70	.150	.150	1.0	1.0	.150	7.50
80	*	*				

Sample # 113.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.455	.290	.638	.749	.341	17.50
10	.410	.258	.629	.744	.306	15.30
20	.393	.214	.544	.678	.267	13.35
30	.347	.209	.603	.723	.251	12.55
40	.297	.199	.670	.778	.231	11.55
50	.232	.172	;742	.831	.193	9.65
60	.200	.155	.775	.854	.171	8.54
70	.156*	*				
80	*	*				

Sample # 114.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.745	.174	.234	.45	.336	16.80
10	.730	.155	.212	.437	.320	16.00
20	.655*	*				
30	.595*	*				
40	.540*	*				
50	.425*	*				
60	.343*	*				
70	.233*	*				
80	.160*	*				

Sample # 115.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.206	.402	1.95	1.58	.326	16.30
10	.199	.288	1.45	1.31	.261	13.05
20	.179	.269	1.49	1.33	.238	11.90
30	.170	.237	1.39	1.275	.217	10.85
40	.150	.204	1.36	1.256	.188	9.40
50	*	.190*				
60	*	.150*				
70	*	*				
80	*	*				

Sample # 116.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.60	.220	.367	.538	.3228	16.14
10	.55	.214	.389	.552	.304	15.20
20	.53	.210	.396	.556	.295	14.75
30	.48	.199	.414	.572	.274	13.70
40	.39	.180	.462	.612	.239	11.95
50	.343	.175	.510	.65	.222	11.10
60	.242	.150	.619	.736	.178	8.9
70	.190*	*				
80	.*	*				

Sample #117.

Degrees.	r.	g.	Ratio.	k.	F.C. Ill.	% Lum.
0	.675	.185	.274	.476	.322	16.10
10	.665	.159	.239	.453	.302	15.10
20	.600	.150	.250	.461	.276	13.80
30	.54*					
40	.45*					
50	.393*					
60	.310*					
70	.215*					
80	.155*					

Sample #118.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.282	.310	1.10	1.08	.304	15.20
10	.269	.242	.898	.940	.253	12.65
20	.253	.230	.91	.95	.241	12.05
30	.229	.215	.94	.968	.221	11.05
40	.215	.197	.915	.954	.205	10.25
50	.195	.175	.896	.937	.183	9.15
60	.170	.156	.918	.957	.163	8.15
70	.150*	*				

Sample # 119.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.258	.310	1.20	1.15	.294	14.70
10	.227	.268	1.18	1.138	.258	12.80
20	.212	.258	1.21	1.158	.245	12.25
30	.196	.237	1.21	1.158	.227	11.35
40	.193	.209	1.08	1.065	.205	10.25
50	.166	.190	1.14	1.11	.184	9.20
60	.150	.166	1.10	1.09	.164	8.20
70	*	*				

Sample # 120.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.595	.163	.247	.476	.283	14.15
10	.512	*				
20	.460	*				
30	.410	*				
40	.393	*				
50	.325	*				
60	.240	*				
70	.165	*				
80	*	*				

Sample # 121.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.303	.267	.88	.928	.281	14.05
10	.267	.220	.823	.886	.237	11.85
20	.255	.215	.845	.902	.230	11.50
30	.223	.208	.933	.962	.214	10.70
40	.204	.180	.881	.928	.189	9.45
50	.176	.171	.970	.980	.173	8.65
60	.150	.150	1.00	1.00	.150	7.50
70	*					
80	*					

Sample # 122.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.60	.150	.250	.461	.277	13.85
10	.57	*				
20	.54	*				
30	.50	*				

Sample # 123.

0	.54	.157	.291	.496	.268	13.40
10	.47	*				
20	.44	*				
30	.42	*				
40	.35	*				

Sample #124.

Degrees.	r.	g.	Ratio.	k.	F.C. Ill.	% Lum.
0	.450	.178	.395	.556	.250	12.50
10	.440	.168	.381	.549	.242	12.10
20	.420	.174	.414	.572	.240	12.00
30	.385	.163	.423	.578	.223	11.15
40	.316	.150	.474	.621	.196	9.80
50	.288	*				
60	.215	*				
70	.165	*				

Sample # 125.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.223	.253	1.09	1.072	.250	12.50
10	.220	.228	1.04	1.034	.227	11.35
20	.219	.215	.983	.990	.217	10.85
30	.213	.209	.980	.987	.211	10.55
40	.190	.190	1.0	1.0	.190	9.50
50	.170	.170	1.0	1.0	.170	8.50
60	*	*				

Sample #126.

0	.430	.150	.345	.529	.228	11.40
10	.385	*				
20	.356	*				
30	.306	*				

Sample # 127.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.237	.209	.883	.930	.221	11.05
10	.232	.199	.857	.909	.211	10.55
20	.215	.196	.911	.950	.205	10.25
30	.203	.190	.935	.965	.196	9.80
40	.190	.170	.894	.937	.178	8.90
50	.166	.164	.988	.995	.165	8.25
60	.150	*				
70	*	*				

Sample # 128.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	⁄ Lum.
0	.128	.090	1. 9	1.450	.204	12.60
10	.128	.145	1. 6	1.15	.192	7.1
20	.129	.170	1.	1.0	.184	8.
30	.130	.157	1.	1.0	.187	8.
40	.150	.150	1.	1.0	.253	7.
50	"	"				
60	"	"				
70	"	"				

Sample # 129.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	⁄ Lum.
0	.316	.150	.475	.602	.197	9.3
10	.294	"				
20	.270	"				
30	.220	"				
40	.220	"				
50	.194	"				
60	.165	"				

Sample # 130.

Light tint yellow paint.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.70	1.70	1.00	1.00	1.70	85.00
10	1.505	1.505	1.00	1.00	1.505	75.25
20	1.36	1.36	1.00	1.00	1.36	68.00
30	1.21	1.21	1.00	1.00	1.21	60.50
40	1.07	1.07	1.00	1.00	1.07	53.50
50	.865	.865	1.00	1.00	.865	43.25
60	.570	.570	1.00	1.00	.570	28.50
70	.265	.265	1.00	1.00	.265	13.25
80	.145	.145	1.00	1.00	.145"	7.25

Sample # 131.

Medium yellow paint,

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.77	1.28	.723	.816	1.44	72.00
10	1.59	1.03	.647	.757	1.20	60.00
20	1.415	1.01	.723	.816	1.16	57.50
30	1.33	.90	.676	.78	1.04	52.00
40	1.21	.675	.557	.687	.831	41.55
50	.97	.595	.613	.732	.710	35.50
60	.70	.343	.489	.631	.442	22.10
70	.34	.235	.690	.790	.269	13.45
80	.15	.140	.93	.961	.144	7.22

Sample # 132.

Dark yellow paint,

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.77	.936	.528	.664	1.18	59.00
10	1.59	.880	.553	.668	1.06	53.00
20	1.50	.790	.526	.663	.993	49.65
30	1.33	.640	.481	.626	.834	41.70
40	1.14	.575	.504	.644	.732	36.60
50	.97	.39	.340	.562	.545	27.25
60	.495	.257	.518	.658	.325	16.25
70	.325	.170	.523	.661	.214	10.70
80	.250	.136	.544	.676	.169	8.45

Sample # 133.

Light brown paint.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.72	.62	.86	.912	.655	32.25
10	.56	.28	.572	.652	.364	18.20
20	.40	.16	.40	.56	.224	11.20
30	.36	.103	.286	.486	.175	8.75
40	.23	.100	.434	.587	.135	6.75
50	.175	.098	.560	.690	.121	6.05
60	.095	*				
70	*	*				

Sample # 134.

Orange yellow paint.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	1.39	.30	.216	.440	.612	30.60
10	1.31	.245	.187	.416	.546	27.30
20	1.16	.215	.185	.416	.483	24.15
30	1.07	.195	.182	.413	.442	22.10
40	.90	.163	.181	.412	.371	18.55
50	.75	.15	.20	.425	.319	15.95
60	.55	.101	.184	.413	.227	11.35
70	.31	.08	.125	.462	.144	7.20
80	.15	.06	.04	.56	.084	4.20

Sample # 135.

Dark brown paint,

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.52	.62	1.19	1.14	.592	29.60
10	.15	.092	.613	.732	.110	5.50
20	.12	.075	.630	.745	.0892	4.46
30	.10	.073	.730	.821	.082	4.10
40	*	*				
50	*	*				
60	*	*				
70	*	*				
80	*	*				

Sample #136.

Deep maroon red paint.

Degrees.	r.	G.	Ratio.	K.	F.C. Ill.	% Lum.
0	.580	.460	.793	.864	.502	25.10
10	.160	.135	.817	.882	.141	7.05
20	.093	.092	1.00	1.00	.093	4.65
30	*	*				

Sample # 137.

Dark blue. Paint.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum,
0	.330	.460	1.39	1.27	.419	20.95
10	.115	.150	1.30	1.22	.141	7.50
20	.082	.080	.975	.984	.080	4.00
30	.068	.068	1.00	1.00	.068	3.40

Sample # 138.

Light blue paint.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.340	.330	1.37	1.26	.340	17.00
10	.150	.150	1.00	1.00	.150	7.50
20	.083	.095	1.14	1.11	.092	4.60
30	.072	.090	1.25	1.186	.085	4.26
40	*	*				

Sample # 139.

Light red paint.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.57	.098	.172	.402	.229	11.45
10	.57	.093	.163	.397	.226	11.30
20	.48	.077	.160	.396	.190	9.50
30	.425	.065	.153	.391	.166	8.33
40	*	*				

Sample # 140.

Dark red paint.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.670	.102	.152	.396	.265	13.25
10	.620	.080	.129	.371	.230	11.50
20	*	*				
30	*	*				

Sample # 141.

Olive green paint.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.127	1.30	.36	1.69	.215	10.75
10	.24	1.10	.457	.607	.145	7.25
20	.100	.165	1.65	1.43	.143	7.15
30	.092	.125	1.36	1.256	.116	5.80
40	.087	.109	1.26	1.192	.104	5.20
50	.075	.10	1.33	1.239	.0927	4.64
60	.070	.092	1.31	1.225	.0858	4.29
70	*	*				

Sample # 142.

Dark green paint.

Degrees.	r.	g.	Ratio.	K.	F.C. Ill.	% Lum.
0	.270	.560	2.07	.427	.115	5.75
10	.17	.22	1.29	.371	.063	3.15
20	.125	.20	1.61	.400	.050	2.50
30	.110	.142	1.29	.371	.0408	2.04

The unit of intensity of illumination commonly used is the "foot candle" which may be defined as the intensity produced upon a surface one foot from a standard flame of one candle power so placed that the rays strike the surface perpendicularly or normal to the surface. Hence in determining the intensity of illumination on any given surface from a light source in any given position there are two factors which must be considered; first, the distance of the surface from the source, and second, the angle which the surface makes with the incident ray. From this we are able to derive the rule:- " Multiply the candle-power intensity of light at the given angle by the reduction factor for that angle and divide the product by the square of the distance."

Experiment showed that for the incident ray normal to the surface and constant in value and a varying angle of reflection, the intensity of illumination on the surface varied only a very small amount throughout the useful range of the photometer. This setting with a constant incident ray also gave evidence that the colors have a much greater effect on the angle of incidence than for the angles of emission. Since in practical illumination both angles vary for each particular position, it was decided from the above named effects of color to maintain the angle of emission constant in securing the data herewith given.

We well know that in any enclosed space the light re-

flected from the bounding surfaces may constitute a considerable portion of the total light, and, therefore, if the surfaces are colored the general illumination will be strongly colored quite without consideration of the illuminant. This principle will be recognized as analogous to the modification of the color of light by a shade over the source. Hence strong or dark colored walls will give the dominant tone to the color rather than that of thelight source.

Diffused light from reflecting surfaces is very useful for,by a mixture of diffused and regular reflection, the quantity of light which will reach a surface is determined. Of the two the diffused reflection is the more important.

A study of the data and curves will show at a glance that the quality of the surface and color are very important factors relating to the absorption of light. The value of Plaster of Paris, a matt white surface, was used as the standard of comparison being 100 % reflecting power as compared with the colors. It must be remembered, however, that the absolute reflecting power is only about 82% of the total light received.

Experiment on this surface as well as the various other samples proved that the so-called "law of the cosine" is not true in consequence of the deviation of the law of cosine of the incident ray. This conclusion was also drawn by Wright some years ago in elaborate experiment.

Next to the white we see several tinted colors in the

light yellows, pulp, and pink that give a percentage reflecting power of important magnitude. This is no doubt due to the strong reflection of white light from the mass of uncolored fibers composing the surface. The very light colors in general diffuse well owing to the uncolored component of reflected light, and, with the exception of the yellows, the reflecting power diminishes very rapidly as the tone of color becomes deep.

The curves show that for all smooth surfaces the reflection follows very nearly the law of the cosine. A very noticeable feature is in the increased reflecting power with the roughnessof the surface. This is very apparent in the commercial papers known as ingrain where a great percentage of the surface fibers reflect white light from the uncolored portion. Roughness in a paper in use, however, permits the surface to become coated with a film of dust and thereby reduce the reflecting power. Contrasted with this a smooth light tinted surface will diffuse well at first but loses its power of reflection rapidly as it becomes soiled. A glance through the data will show that the dark blues, greens, and browns in all their varieties have very low reflecting powers and in commercial work should, therefore, be avoided where effective illumination is desired.

In fabric or burlap wall coverings there is considerable loss from multiple reflections from the surface of the dyed fiber producing an effect of "richness" of color. This too, gives a more uniform diffusion which is very noticeable in the regularity of all the curves for fabric coverings. A very interesting

feature to note in the burlaps is that coating the top surface of the projecting fibers with silver will add about 10% to the effective reflecting power of the ground surface color. Sample #76, a very light burlap, is conspicuous for a large percentage of regular diffusion which is probably due to thebbundles of uncoloredfibers apparent in the structure. Burlaps, like rough papers, will rapidly loose their reflecting powers as they become coated with dust.

Turning our attention to the results secured from the samples of painted surfaces we see a marked difference in the curves, as compared with the other surfaces. The paints were carefully prepared on sheet metal so that they presented a very smooth surface. Paint gives a very considerable amount of surface reflection of white light in spite of the pigmentswith which they are colored . This is because of the fine particles of color intermingled with the white pigments. Diffusion from paint is very regular and from the luster of the surface is very strong in comparison with the papers and ather wall coverings. The color effects show the same characteristics in paints as the other surfaces.

Samples #130, 131,and 132 which are very light colors and yellow, show a great regular reflection and much as a matt surface. The darker colors however, for the incident ray normal to the surface show by the curves a rapid diminution of regular reflection as the incident ray leaves the normal position.

TABLE of REFLECTING COEFFICIENTS.

COLOR.	0^0	10^0	20^0	30^0	40^0	50^0	60^0	70^0	80^0
White	100	91.5	80.	70.	60.	47.	34.	18.	11.
Light Yellow	88.	81.	74.	64.	58.	43.	30.	19.	9.
Yellow paint	85.	75.	68.	61.	54.	43.	29.	13.	7.
Yellow paper	81.	76.	67.	58.	53.	38.	26.	17.	8.
Med. Yellow Paint	73.	60.	57.	52.	41.	35.	22.	14.	7.
Yellow burlap	67.	59.	56.	50.	38.	34.	24.	13.	8.
Dark Yellow Paint	59.	53.	50.	42.	37.	27.	16.	11.	9.
Light Gree	56.	52.	43.	40.	34.	23.	17.	12;	
Light Brown B	40.	33.	29.	26.	21.	16.	13.	10.	
LIGHT Orange B.	41.	34.	30.	30..	29.	22.	15.	11.	
Light Brown P	40.	33.	29.	26.	21.	16.	13.	10.	
Pink	35.	25.	23.	20.	19.	14.	12.	9.	
Light Brown Paint	32.	19.	11.	9.	7.	6.			
Dark Blue	30.	23.	18.	15.	12.	11.	10.		
Light Blue Burlap	35.	29.	27.	26.	23.	18.	14.	10.	
Light Green "	29.	26.	22.	20.	18.	17.	12.	9.	
Orange Burlap	25.	22.	21.	19.	18.	14.	12.		
Dark Blue Paint	21.	7.	4.	3.					
Dark Green Burlap	20.	17.	15.	14.	13.	11.	9.	8.	
Dark Red paper	20.	18.	17.	14.	8.	7.	4.		
Dark Brown	17.	14.	13.	12.	10.	9.	7.	6.	
Olive Green Paint	11.	7.	7.	6.	5.	4.5	4.		
Purple Burlap	10.	9.	8.4	8.	7.5				

From the foregoing we can now summarize the qualities which effect the reflecting power of the surface into:-

First, the angle at which the light strikes the surface;

Second, the nature of the surface(smoothness);

Third, the color of the materiel; and,

Fourth, the color of the illuminant.

In the illumination of rooms the diffused reflection from the walls and ceiling is an important item. We can determine to what extent such reflection would be of benefit by supposing a single light source to illuminate the enclosure. This source will give out its light in all directions and every ray will reach some point on the surface of the walls from which point it will be re-reflected and so on indefinitely until it is entirely absorbed. The increase in illumination produced by this complex reflection will equal unity divided by the quantity, unity minus the coefficient of reflection or reflecting power of the walls.

$$\text{" Illumination} = \frac{1}{1 - C.} .$$

Hence from the preceeding table and this equation we can deduce a very close estimate of the coefficient of the reflecting power and the illumination for any given color. Extreme accuracy, however, cannot be secured because of the complex surroundings of the enclosure such as doors, furnishings, and the like. Any secondary reflection has approximately the same coefficient of reflection as the first, so that for two reflections of the same beam , the intensity of the beam that finally leaves

the surface is that of the incident beam times the square of the coefficient of diffusion; and so on for the higher powers.

The color and quality of the surface of walls, therefore, we see plays a very important part in practical illumination, for rooms with very dark colored walls requires a very much more liberal use of illuminants for an equal intensity than those with white or lightly colored walls. The difference, as seen from the table preceeding, is great enough to be a considerable factor in the economics of illumination in every case where artistic considerations are not of prime importance.