LABORATORY PROFICIENCY TESTING PROGRAM

PROFICIENCY TESTING

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LABORATORY PROFICIENCY TESTING PROGRAM

REPORT NO.4

GLASS EXAMINATION

PROJECT STAFF

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Points of view or opinions stated in this document are those of the authors and do not necessarily represent the official position or policies of the U.S. Department of Justice.

FOREWORD

The analysis summarized in this report is the fourth of a series that will be made in conjunction with this proficiency testing research project.

In the course of this testing program participating laboratories will have analyzed and identified ten different samples of physical evidence similar in nature to the types of evidence normally submitted to them for analysis.

The results of Test Number Four are reflected in the charts and graphs which follow.

The citing of any product or method in this report is done solely for reporting purposes and does not constitute an endorsement by the project sponsors.

Comments or suggestions relating to any portion of this report or of the program in general will be appreciated.

July 1975

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BACKGROUND

This laboratory proficiency testing research project, one phase of which is summarized in this report, was initiated in the fall of 1974.

This is a research study of how to prepare and distribute specific samples; how to analyze laboratory results; and how to report those results in a meaningful manner. The research will be conducted in two cycles, each of which will include five samples: a controlled substance; firearms evidence; blood; glass, and paint.

Participation in the program is voluntary. Accordingly, invitations have been extended to 235 laboratories to share in the research. It is recognized that all laboratories do not perform analyses of all possible types of physical evidence. Thus, in the data summaries included in this report, space opposite some Code Numbers (representing specific laboratories) may be blank, or marked "No Data Returned."

A final project report will be prepared at the conclusion of Cycle II.

The Project is under the direct control of the Project Advisory Committee whose members' names are listed on the Title Page. Each is a nationally known criminalistic laboratory authority.

Supporting the Project Advisory Committee in their efforts is the Forensic Sciences Foundation with additional support from the National Bureau of Standards in the areas of sample evaluation and data analysis and interpretation.

SUMMARY

Test Sample #4 consisted of glass samples A and B, packaged in a plastic box. The samples were mailed on April 28, 1975 with instructions to handle the sample in a manner similar to like evidence and submitted for analysis.

Test Sample #4 was sent to 234 laboratories. Three of those laboratories served as referees, reducing the actual number to 231.

In the accompanying data summaries, 124 laboratories responded with completed data sheets, 49 laboratories responded that they did not do glass analysis and no response was received from 61 laboratories. This represents a participation rate of 68%.

No effort was made in this report to highlight areas wherin laboratory improvements might be instigated.

ANNEX A

FIGURE 1.

LAB CODE A-_____

☐ CHECK HERE (AND RETURN) IF YOU DO NOT PERFORM GLASS EXAMINATION

DATE RECEIVED IN LAB_____

DATE PROCESSED IN LAB_____

DATA SHEET

PROFICIENCY TESTING PROGRAM

TEST #4
GLASS EXAMINATION

Item A represents a glass sample taken from the scene of a burglary. Item B represents a glass sample taken from the trousers of a suspect.

1. Item A could have common origin with Item B.

   ☐ YES

   ☐ NO

   ☐ Inconclusive

2. What information (quantitative and qualitative) did you develop to arrive at your conclusion in No. 1?

   Item A

   Item B

3. Method(s) and instrument(s) used:

DATA SHEETS MUST BE RECEIVED AT THE FOUNDATION OFFICE BY MAY 30, 1975.

ANNEX B

National Bureau of Standards Analysis

LABORATORY TESTING PROGRAM

Test No. 4 - Glass Examination

In Test No. 4, 234 laboratories were each sent two pieces of glass referred to as A and B. Participants were asked three questions: (1) Could item A have a common origin with item B? (2) What information was developed to answer question 1? (3) What methods and instruments were used?

Of the 234 laboratories, 124 responded with data, 49 indicated they do not do glass analysis, and 61 did not respond. A tabulation of the codes for laboratories in each of these last two categories is given in Table 1.

Both the supplier of the glass samples and the referee laboratories indicate, in Tables 2 and 3, that A and B do not have a common origin. 118 participating laboratories reported A and B could not have a common origin, 4 were inconclusive. These results are tabulated in Table 4 for each of the 124 responding laboratories.

The supplier notes in Table 2 that the thickness of glass B is more uniform than the thickness of glass A. It may be noted from Tables 2 and 3 that the refractive indexes and densities of the glass B samples are also more uniform.

A quantitative analysis was made of the two most frequently reported methods (see below) for the laboratories which reported data suitable for this purpose. Table 5 shows refractive index and density differences between A and B. The density measurements produced greater variations than did the refractive index measurements. The average refractive index difference for 35 participating laboratories (those that reported to at least four decimal places) agrees well with the refractive index differences reported by the referee laboratories and the sample supplier. However, the density differences in Table 5 do not agree as well. Of the 12 laboratories reporting density data that can be interpreted quantitatively, two reported that A had a greater density than B, while the reverse was reported by the other 10.

On the average, 2.7 methods per laboratory were reported for question 3. The relative frequencies of the methods reported are shown in Table 6. Tables 7 and 8 show the responses to questions 2 and 3 from each laboratory. Table 9 was especially requested by the Project Advisory Committee.

This annex was prepared by the Law Enforcement Standards Laboratory (LESL) of NBS, in conjunction with the NBS Laboratory Evaluation Technology Section (LETS). The anonymous test results reported by the participating forensic laboratories were analyzed and tabulated by Jeffrey Horlick and Charles Leete of LETS, and Robert Mills of LESL. This work was supported by the National Institute of Law Enforcement and Criminal Justice, Department of Justice.

Table 1

THE FOLLOWING LABS INDICATED THEY DO NOT DO GLASS ANALYSIS:

706	775	845	953
711	785	860	983
720	788	862	992
721	791	875	998
735	793	877	
741	803	886	
743	807	913	
744	810	918	
749	812	920	
753	824	924	
755	826	927	
758	828	932	
759	830	935	
761	841	950	
767	844	951	

Total Labs = 49

THE FOLLOWING LABS DID NOT RESPOND:

703	738	825	879	942
707	764	834	887	946
708	770	836	891	964
710	772	850	898	966
715	774	858	900	972
723	780	859	902	973
724	781	861	903	984
728	782	864	904	985
732	795	865	905	988
733	811	867	912	
734	814	869	914	
736	816	870	917	
737	817	871	937	

Total Labs = 61

Table 2

SUPPLIER'S CHARACTERIZATION OF SAMPLES

Thickness

The thickness of glass B is much more uniform than the thickness of glass A.

Color

Both are untinted glasses.

Fluorescence

Glass B has tin dissolved in one of its surfaces, and thus will fluoresce when exposed to UV light. Glass A does not contain tin.

Refractive Index

Measurements made on six samples gave the following results for refractive index, N_D (Sodium Line):

	A	B
	1.5167	1.5186
	1.5167	1.5185
	1.5158	1.5186
	1.5167	1.5185
	1.5168	1.5186
	1.5166	1.5186
Average:	1.51655	1.5186
Standard Deviation:	0.0004	0.00005

Density

Density measurement results for six samples are as follows:

	A	B
	2.4860 g/cm^3	2.4945 g/cm^3
	2.4862	2.4947
	2.4821	2.4949
	2.4876	2.4949
	2.4859	2.4944
	2.4852	2.4952
Average:	2.4855 g/cm^3	2.4948 g/cm^3
Standard Deviation:	0.002	0.0003

Composition

	A	B
SiO_2	73.37%	73.20%
Na_2O	13.16	13.64
CaO	8.26	8.87
MgO	3.61	3.95
Al_2O_3	1.22	0.15
K_2O	0.24	0.03
SO_3	0.18	0.25
Fe_2O_3	0.11	0.08
Total	100.15%	100.17%

Table 3

RESULTS FROM THREE REFEREE LABORATORIES

Lab 1. (NBS was requested to do only refractive index and density measurements)

Refractive Index (3 specimens)

	A	B
1	1.51552	1.51845
2	1.51648	1.51844
3	1.51550	1.51844
Average:	1.51583	1.51844
Standard Deviation:	0.0006	0.000006

Refractive index of each specimen was determined at $\lambda = 0.5893$ μm, the mean of the D lines of sodium at 20°C. These determinations are considered to be accurate to within 2×10^{-5}.

Density

	A	B
1	2.4740 g/cm^3	2.4919 g/cm^3
2	2.4802	2.4916
3	2.4739	2.4919
Average:	2.4761 g/cm^3	2.49185 g/cm^3
Standard Deviation:	0.004	0.0002

Densities were determined using the ASTM C-729 method, which is a sink-float comparator method using a combination solution of iso-propyl salicylate and S-tetra bromethane. The determination of the difference in density between the two glasses is considered to be accurate to 1×10^{-4}, although the absolute accuracy of any one determination may be no greater than 1×10^{-3}.

Lab 2.

Refractive Index (N_D Sodium Line)

A	B
1.516	1.518

Refractive index measurements by Becke line method; samples A and B showed a clear difference when measured comparatively.

Table 3 continued

Lab 2 continued:

Density

A	B
2.479 g/cm^3	2.485 g/cm^3

Density determined by pycnometer measurement of liquid mixture in which glass samples floated; samples A and B showed unequivocal difference in density when measured comparatively.

Lab 3.

Fluorescence*

Sample A No fluorescence in U.V. (short wave)

Sample B Fluorescence on one side in U.V. (short wave)

*Would normally stop at this point since A is different from B.

Refractive Index

Sample A N_C - 1.5129 N_D - 1.5157 N_F - 1.5216
(Dispersion curve different shape from B)

Sample B N_C - 1.5158 N_D - 1.5185 N_F - 1.5247

Refractive index and dispersion curve was done using AOAC method with hot stage, monochromator, and Phase-Star Microscope.

Density

A	B
2.4911 g/cm^3	2.5054 g/cm^3

Density by sink-float method using bromoform-alcohol mixture at 25° $\pm$ 0.1°C with plumb bob and density balance.

Table 4

RESPONSES TO QUESTION 1: Item A could have common origin with Item B?

Lab Code	Response
705	NO
709	NO
712	NO
713	NO
717	NO
718	NO
719	NO
722	NO
726	NO
727	NO
729	NO
730	NO
731	NO
739	NO
740	Inconclusive
742	NO
745	NO
746	NO
747	NO
748	NO
750	NO
751	NO
752	NO
754	NO
756	NO
757	NO
760	NO
762	NO
763	NO
765	NO
766	YES
768	NO
769	NO
773	NO
777	NO
778	NO
779	NO
783	NO
784	YES
786	NO
787	Inconclusive
789	NO
790	NO
792	NO
794	NO
796	NO
797	NO
798	NO
799	NO

Lab Code	Response
805	NO
806	NO
809	NO
813	NO
815	NO
818	NO
820	NO
821	NO
822	YES
823	NO
827	NO
829	NO
831	NO
832	NO
833	NO
835	NO
837	NO
838	NO
839	NO
842	NO
843	NO
847	NO
848	NO
849	NO
852	NO
853	NO
854	NO
855	NO
856	NO
863	NO
866	NO
868	NO
872	NO
873	NO
874	NO
876	NO
880	NO
883	NO
884	NO
885	NO
888	NO
889	NO
892	NO
894	NO
895	NO
897	NO
899	NO
907	NO
908	NO

Lab Code	Response
915	NO
921	NO
923	NO
925	NO
926	NO
931	NO
938	NO
944	NO
948	NO
958	NO
960	NO
961	NO
962	NO
969	NO
970	NO
974	NO
975	NO
978	NO
979	NO
980	NO
986	NO
987	NO
989	NO
994	NO
995	NO
999	YES

Total labs Responding: 124

NO = 118

YES = 4

#Inconclusive = 2

Table 5

Refractive Index and Density Differences:
B minus A

	Differences in Refractive Index	Differences in Density - g/cm^3
Laboratory 1 (NBS) - Ave. of 3 pieces	0.00261	0.01575
Laboratory 2 -	0.002	0.006
Laboratory 3 - RI measured at 3 λ's	0.0029/0.0028/0.0031	0.01430
Sampler Supplier - Ave. of 6 pieces	0.00205	0.00930
Average of Results from 35 Labs	0.00254	---------
Standard Deviation of these 35 results	0.0007	

Table 6

Relative Frequencies of the Reported Methods

Refractive Index	90
Density	77
Thickness	50
U.V. Light	42
Elemental Analysis	18
Dispersion Curves	14
Color	9
Dispersion Staining	8
X-Ray Fluorescence	8
Physical Edge Match	4

Table 7

RESPONSES TO QUESTION 2: Information Developed.

	Sample A	Sample B
705	Elemental composition of "A" differs from that of sample "B". Refractive Index of "A" differs from sample "B". Dispersion of light from sample "A" differs from sample "B".	
709	Item A fluoresces pink.	Item B fluoresces white.
712	No fluoresence on either side. Thickness is .222 - .223 inches. Refractive index is $n_D^{25} = 1.5156 \pm .0004$	Fluoresces on one side - float glass. Thickness is .223 - .224 inches. Refractive index is $n_D^{25} = 1.5185 \pm .0004$
713	Thickness is 5.67mm. Refractive index of A less than 1.516.	Thickness is 5.70mm. Refractive index of B greater than 1.516.
717	Thickness is .2282 inches. Relative Density less than B. Refractive index is approx. 1.5186.	Thickness is .2252 inches. Relative Density greater than A. Refractive index is approx. 1.5206.
	Spectrograph indicated the presense of tin in B and none detected in A.	
718	Colorless under ultraviolet light. Thickness is .226 inches.	Yellow fluorescence under UV light. Thickness is .225 inches.
	B is approx. .005 grams/cc more dense than A. Refractive index of B is approx. .002 units greater than A.	
719	A has different optical and physical qualities and different chemical contents from B.	
722	Visual - qualitative; Refractive index - qualitative; Density gradient-qualitative.	
726	Refractive index is 1.516. Density is less than B. Fluorescence is non-detectable.	Refractive index is 1.518. Density is greater than A. Fluorescence - light blue on one side.
727	Becke line readings were: 656: 66.5 - 71.5 Average 589: 73.3 - 75.4 Average 486: 86.1 - 88.7 Average	Becke line readings were: 656: 61.6 - 67.0 Average 589: 67.5 - 70.7 Average 486: 80.6 - 83.9 Average
	Glass chips were at different levels in the sink float method.	
729	There is difference in fluorescence between the two samples.	
730	Optical density @ 500nm = .160 U.V. cutout = 318 nm. Emission Spec shows no tin.	Optical density @ 500nm = .158 U.V. cutout = 325 nm. Emission Spec shows tin.
	Comparison sample to B shows lower Mg, Al, Ca, Zn, higher Cu.	
731	Density gradient shows .0008 gm/cc difference between A and B.	
739	Refractive index of A (approx. 1.514) less than B (approx. 1.516). Density of A less than B on comparison basis.	
740	Refractive index = 1.5160 Elemental - Ca, Fe, Zn, SrZn Count ratio - not concentration	Refractive index = 1.5191 Elemental - Ca, Fe, Zn, SrZn Count ratio - not concentration

Ca/Fe	Ca/Zn	Ca/Sr	Ca/Zn
4.7	53.0	6.5	25.0

Ca/Fe	Ca/Zn	Ca/Sr	Ca/Zn
6.26	53.0	4.6	13.5

	Sample A	Sample B
742	Thickness is .222 of an inch. No fluorescence to UV light. Refractive index and dispersion: N_D^{25}=1.515028, N_F^{25}=1.520215, N_C^{25}=1.512824 Vx=69.68	Thickness is .224 of an inch. One surface fluorescences to UV light. Refractice index and dispersion: N_D^{25}=1.517914, N_F^{25}=1.523249, N_C^{25}=1.515636 Vx=68.03
745	A is less dense than B. A has lower (estimated .002-003) refractive index than B. Refractive index is approx. 1.517 Thickness is .225 inch.	Similar green tint to A when viewed edgewise. Refractive index is approx. 1.5185 Degree of dispersion approx. same as A. Thickness is .224 inch.
746	Refractive index is 1.516 (comparative).	Refractive index is 1.518 (comparative).
	A is easily separated from B by flotation; A is less dense than B.	
747	Thickness is .223 inches. Refractive index is 1.515665 Dispersion is 58.29	Thickness is .224 inches. Refractive index is inconclusive. Dispersion is 55.49
748	Color: Blue-green tint. Fluorescence: None. Thickness: .2213 inch to .2216 inch. Density: 2.484 g/ml	Color: Blue tint. Fluorescence: Fluoresces on one surface. Thickness: .2246 inch to .2248 inch. Density: 2.445 g/ml
750	No fluorescence to UV light.	Marked yellow fluorescence to UV light.
	A is less dense than B and a lower refractive index than B on a comparison basis.	
751	Thickness is .224 inch. Short wave UV: Dark purple absorbance. Refractive index (direct): 1.5163 - 1.5164	Thickness is .225 - .226 inch. Short wave UV: one side fluoresces white/yellow. Refractive index (direct): 1.5182 - 1.5184
	Refractive index and dispersion (Emmons Double Variation Method) gives: N_D^{25}= 1.5165	N_D^{25}= 1.5183
	Both A and are isotropic, concoidal fractures - apparent glass.	
752	Thickness is 6.19 mm. A is less dense than B and has a lower refractive index than B.	Thickness is 6.21 mm.
754	Glass is slightly darker green in color. No fluorescence under UV light.	Glass is slightly lighter green in color. One surface fluoresces under UV light.
	A is less dense than B and refractive index does not match B.	
756	Thickness = .568 cm. N_D= 1.5162, N_C= 1.5137, N_F= 1.5226	Thickness = .572 cm. N_D= 1.5187, N_C= 1.5162, N_F= 1.5254
	Dispersion curve for A tapers in 486-500 nm region while B is straight line.	
757	No fluorescence under short wave UV light.	One side fluoresces under UV light.
760	Orange fluorescent color under UV light. Thickness is 5.61 mm (average).	Yellow fluorescent color under UV light. Thickness is 5.71 mm (average).
	A is less dense than B and has a lower refractive index than B (comparative basis).	

	Sample A	Sample B
762	Thickness - 5.665 mm.	Thickness - 5.710 mm.
	A has lower density than B and lower refractive index than B at 25°C ± .1°C.	
763	Refractive index is 1.512 - 1.516.	Refractive index is 1.516 - 1.520.
	Relative density of A is less than B.	
765	Thickness is 5.69 mm.	Thickness is 5.72 mm.
	Refractive index @ 26½°C = 1.5153.	Refractive index @ 26½°C = 1.5158
	Density @ 25°C = 2.4621 and less than B.	
766	Refractive index of both A and B is 1.560.	
	Density Gradient - A floats in tube at same level as B.	
768	A does not fluoresce under UV light.	B fluoresces yellow on one side with UV light.
769	Thickness = .2237 in.	Thickness = .2249 in.
	Density = 2.4856 @ 27°C	Density = 2.4979 @ 27°C
	Spec. Grav. = 2.4945 @ 27°C	Spec. Grav. = 2.5068 @ 27°C
	Refractive index = 1.5157 @ 20.5°C	Refractive index = 1.5185 @ 20.5°C
	Normal color of both A and B is greenish-blue.	
	Ultraviolet fluorescence of A is gold and B is bright yellow (@ 254 nm)	
773	Neither side fluoresces under short wave UV light.	One side is fluorescent under short wave UV light.
777	Color of A and B are similar (Blue-green).	
	Thickness = .224 inches.	Thickness = .225 inches.
	N_D= 1.515	N_D= 1.518
	Dispersion of A and B are similar.	
	Density similar to B (about 2.48 ± .02)	Density similar to A (about 2.51 ± .02)
778	A and B do not have some refractive index (comparative basis).	
	A contains K.	B has 2 times Zr than A.
779	Refractive index and density on both A and B.	
783	Thickness: .227 - .228 inch.	Thickness: .224 - .225 inch.
	Refractive index: 1.5161 - 1.5163	Refractive index: 1.5180 - 1.5182
784	Thickness: 5.77 mm.	Thickness: 5.71 mm.
	Refractive index on both A and B greater than 1.516 and less than 1.518.	
	Elemental composition (both A and B) - Si, Ca, Fe, Sr, and Zr.	
	Density of A identical to B.	
786	UV fluorescence - none.	UV fluorescence - slight yellow.
	Column density determination.	Column density determination.
	Tin not detected.	Tin present.
787	Match by "jigsaw" method gave negative results.	
	Gradient density method was used with inconclusive results.	
789	Density and refractive index of A less than B.	
790	Thickness: .2218 inch average.	Thickness: .2248 inch average.
	A is less dense than B.	
	Temperature match to Silicone oil:	
	nC - 61.1°, nD - 67°, nF - 79.8°	nC - 66°-67.5°, nD - 75°, nF - 85.6°-87°

	Sample A	Sample B
792	Refractive index of B is higher than A at three wavelengths (488, 586.6, 656.3).	
794	No fluorescence under short or long wave UV light. Thickness: 5.23 mm Refractive index: 1.5162	Fluorescence on one side under short wave UV light. None under long wave. Thickness: 5.21 mm Refractive index: 1.5189
796	Specific gravity = 2.4884 Thickness = .225 inch.	Specific gravity = 2.4994 Thickness = .224 inch.
797	Refractive index = 1.5174 (Emmons Double Variation Method) Refractive index = 1.5165 (direct)	Refractive index = 1.5193 Refractive index = 1.5184 (direct)
798	UV light (short and long wave) was used on both A and B. Refractive index and Gradient density were determined on both A and B.	
799	Both surfaces of A absorb short wave UV. Refractive index - both surfaces 1.51560 Density of A is 2.48	One surface of B fluoresces yellow/green with short wave UV. Refractive index - side which fluoresces is 1.5189, other side is 1.5172 Density of B is 2.50
805	Thickness: .223 inches Does not contain tin. A is less dense than B. Dispersion curve of A differs from B primarily in the yellow-red region.	Thickness: .224 inches Tin present.
806	A and B have same thickness - 5.7 mm A and B have same edge color. A and B differ in specific gravity - Sink Float method. Refractive index report as temp. of Silicon oil: Avg. (going up) 74.2°C Avg. (down) 73.7°C	 Avg. (going up) 68.8°C Avg. (down) 68.4°C
809	Visual comparison of color with B. Thickness measurements. Examination under UV light. Density gradient comparison with B. Emission spectrographic analysis.	
813	Refractive index and density of a less than B. Dispersion staining color in 1.516 oil was blue (ambient temp.). X-ray fluorescence elemental ratios: $\frac{\text{Calcium}}{\text{Iron}} = 3.74$ $\frac{\text{Calcium}}{\text{Strontium}} = 36.85$ $\frac{\text{Calcium}}{\text{Zirconium}} = 15.76$	 Dispersion staining color in 1.516 oil was blue violet & red orange. $\frac{\text{Calcium}}{\text{Iron}} = 4.82$ $\frac{\text{Calcium}}{\text{Strontium}} = 18.18$ $\frac{\text{Calcium}}{\text{Zirconium}} = 9.11$
815	Thickness: .225 inch Refractive index: 1.516 (not absolute) Color of both A and B is light green.	Thickness: .225 inch Refractive index: 1.519 (not absolute)
818	B is significantly denser than A.	

	Sample A	Sample B
820	Does not fluoresce under short wave UV light. N_D^{25} - 1.5166	Flouresce under UV light. N_D^{25} - 1.5185
821	Thickness of both A and B is .223 inches. Color of both A and B is clear. Density: 2.480 Refractive index: 589nm 1.519 488nm 1.524	Density: 2.483 Refractive index: 589nm 1.521 488nm 1.528
822	Thickness and optical qualities of A and B are similar.	
823	Visual examination showed both A and B had a slightly green tint. Polarized microscopic examination indicated that both A and B were possibly glass. Refractive index analysis using Becke line technique indicated difference between A and B.	
827	Density: 2.56 approx. Thickness: .22 in approx. Fluoresces orange in short wave range. Elements present: Na, Si, Mg, Ca N_D= 1.5150, N_F-N_C = .0082 approx.	Density: 2.50 approx. Thickness: .22 in approx. Fluoresces green in short wave range. Elements present: Na, Si, Mg, Ca N_D = 1.5180; N_F-N_C = .0083 approx.
829	Refractive index (qualitative) on A and B.	
831	Found difference with comparative density using brominated solvent and alcohol mixture.	
832	Color and appearance of A and B similar. Density gradient of A in mid-2.50 region.	Density gradient of B in lower 2.50 region.
833	Index of refraction: 1.5166 $\pm$ .0002 Ultraviolet cutoff: 337mu(50% absorption) Thickness: .2224" $\pm$ .0002 Density gradient: 245.2/310mm Fluorescence: None visible short or long wave. Fluorescence spectrum: Excitation - 250 Emission - 505mu	Index of refraction: 1.5196 $\pm$ .0002 Ultraviolet cutoff: 333mu(50% absorption) Thickness: .2247" $\pm$ .0002 Density gradient: 250/310mm Fluorescence: Short wave imparts yellow green fluorescence on one face. Fluorescence spectrum: Exitation - 250 Emission - 370 and 503mu Emission intensity approx. 10x greater than than A
835	Specific gravity different in both samples. Refractive index different in both samples. Thickness of both samples averaged the same. UV examination (short wave) - minute differences noted. Spectrographic analyses - spectra revealed no significant differences.	
837	UV light revealed no fluorescence. Dispersion characteristics: match at 588nm (oil 1.522 at 38°C)	B fluoresced on one side to UV light. Dispersion characteristics: match at 528nm (oil 1.522 at 38°C)
838	Refractive index(sodium light): 1.5164	Refractive index(sodium light): 1.5185
839	Thickness: .221" Refractive index: Match at 625 to 503mu. (1.520 oil at 34°C)	Thickness: .224" Refractive index: Match at 574 to 509 mu. (1.520 oil at 34°C)
842	Negative on Flotation, Density gradient, and refractive index.	

	Sample A	Sample B
843	Density: 2.480	Density: 2.510
	Shear wave and longitudinal velocities vary to such an extent between A and B that they could not have a commonality of source.	
847	Thickness: .2237 - .2238"	Thickness: .2246 - .2247"
	Refractive index (sodium line): 1.516	Refractive index (sodium line): 1.519
	Dispersion (V) of A higher than B.	
	Qualitative difference in density.	
848	Refractive index: match with silicone oil at 74.2°C.	Refractive index: match with silicone oil at 68.0°C.
849	Color, thickness, and refractive index of A and B.	
852	Density quantitative differences in A and B.	
	Thickness, Refractive index, and Dispersion qualitative differences in A and B.	
853	Thickness: .227"	Thickness: .224"
	Approx. Density: 2.400 gm/cm^3	Approx. Density: 2.532 gm/cm^3
	Refractive index: 1.5166	Refractive index: 1.5185
854	UV(short wave): no fluorescence	UV(short wave): yellow fluorescence
	Relative density: A differs from B.	
	Refractive index: 1.513	Refractive index: 1.515
	X-ray fluorescence:	
	$K_\alpha^{Ca}/K_\alpha^{Sr}$: .87 $\pm$ .03	.81 $\pm$ .03 (K_α^{Ca} -- preset at 20,000 counts)
	$K_\alpha^{Ca}/K_\alpha^{Fe}$: 2.32 $\pm$ .04	3.04 $\pm$ .04
855	Thickness, color and tint, comparative density, and comparative refractive index.	
856	Thickness: .2225 to .2230"	Thickness: approx. .2246"
	Appears blue under UV lamp.	Appears yellow under UV lamp.
	A does not have same density as B.	
	A has lower refractive index than B (A less than 1.514 and B equal or greater 1.514).	
863	Refractive index: 1.5157	Refractive index: 1.5190
	Thickness: 5.61mm	Thickness: 5.72mm
866	Refractive index: 1.5145, 1.5147	Refractive index: 1.5176, 1.5177
	Density: 2.4523, 2.4739	Density: 2.4763, 2.49
868	A and B are similar in color and width, B has a higher refractive index than A.	
872	Density, Refractive index, Spectrographic composition.	
873	Refractive index: 1.5156	Refractive index: 1.5190
	Specific gravity of A different from B.	
874	Has weak or absence fluorescence.	Has strong yellowish-orange fluorescence.
	A has a lower density than B.	
876	Diameter: 5.59mm	Diameter: 5.70mm
	Refractive index: 1.516 at 589.6 mu	Refractive index: 1.519 at 589.6 mu
	Density of A is less than B.	
880	Visual observation showed A to have an apparent deeper green tint. Short wave UV showed greater fluorescence on A. Two samples differed by more than .001" in thickness. X-ray spectrometer revealed a difference in chemical composition. Rough refractive index determination showed a significant difference.	

	Sample A	Sample B
883	Sample is not float glass. Mean thickness: 5.66 mm Refractive index: 1.51571	Sample is float glass. Mean thickness: 5.70 Refractive index: 1.51866
884	Thickness: .2235" A is less dense than B.	Thickness: .2245"
885	Iron and Zirconium content of A different from B (X-ray fluorescence). Infared scans on a differential basis showed differences in the composition of the two samples.	
888	Thickness: 5.517 mm Color difference Dispersion curve is different between A and B. Refractive index: N_C= 1.5131, N_D= 1.5155 N_F= 1.5223	Thickness: 5.5205 mm Color difference Refractive index: N_C= 1.5161, N_D= 1.5186 N_F= 1.5249
889	UV examination: no fluorescence Refractive Index: 1.5158	UV examination: + fluorescence Refractive index: 1.5181
892	A is less dense than B. No tin by elemental analysis. Refractive index of A less than B.	Presence of tin by elemental analysis.
894	Density of A is less than B. $N_D^{45.2}$= 1.5163 (match temp. N_D^{25}= 1.524 is 45.2°C for sample A while $N_D^{48.0}$ = 1.5193 (match temp. for Cargille liquid N_D^{25} = 1.528 is 48.0°C)	
895 897	Density Refractive index: 1.516 Thickness: .227 inch Absorbs short wave UV light. Density of A is less than B.	Density Refractive index: 1.518 Thickness: .224 inch One side fluoresces yellow under UV light.
899	Thickness: .2236 $\pm$ .0003 Refractive index: 1.5162 No UV fluorescence	Thickness: .2253 $\pm$ .0004 Refractive index: 1.5174 Strong UV fluorescence one side only
907	A and B compared on basis of: 1. Density - differ (density gradient) 2. Refractive index - differ (interpolated from 3) 3. Dispersion - differ (McCrone dispersion staining) 4. Metallic composition - similar (x-ray fluorescence)	
908	Refractive index: 1.512 - 1.516 Comparative density of A is less than B.	Refractive index: 1.516 - 1.520
915	Thickness: .223 - .224" Fluorescence under UV: no n_D= 1.5161_8 V: 55.82_7	Thickness: .225" - .226" Fluorescence under UV: yes n_D= 1.5187_8 V: 55.72_9

	Sample A	Sample B
921	Refractive index: 1.5155	Refractive index: 1.5185 B has a greater density than A.
923	R.I., density, and gross physical measurements were made on both A and B.	
925	Thickness: .223 inches nC = 1.5132, nD = 1.5159, nF = 1.5228 Density = less than 2.499 gm/cc^3	Thickness: .225 inches nC = 1.5159, nD = 1.5186, nF = 1.5254 Density = 2.499 gm/cc^3
926	Thickness: .2237" A is less dense than B.	Thickness: .2248"
931	Refractive index: 411 nm 1.508 593 nm 1.516 $\pm$ .001	Refractive index: 411 nm 1.511 593 nm 1.519 $\pm$ .001
938	Density: 2.486 g/cc Refractive index: 1.516 (white light) Fracture initiation marks were different on A and B indicating that glass samples were broken differently. Slight microscopic color difference between A and B.	Density: 2.496 g/cc Refractive index: 1.519 (white light)
944	Density of A and B are different.	
948	A has lesser density than B. Contains Na, Si, Ca A and B have similar Refractive index.	Contains Na, Si, Ca and trace of Mg
958	A and B were measured for glass color, glass thickness, refractive index, density.	
960	Density gradient comparison made for A and B, refractive index, x-ray fluorescence, and UV light with B giving white fluorescence under short wave UV light.	
961	B strongly fluoresced on one surface under UV illumination, while A exhibited a much weaker fluorescence under the same conditions. A is less dense than B. Refractive index measurements were not clear-cut.	
962	N_C - 1.5139, N_D - 1.5164, N_F - 1.5228	N_C - 1.5155, N_D - 1.5182, N_F - 1.5249
969	No fluorescence under short wave UV light.	Fluoresces under short wave UV light.
970	Physical, UV, Refractive index, etc.	
974	Thickness: .2227" Fluorescence: none Density of A is less than B. Refractive index: C - 1.5131, D - 1.5159 F - 1.5227	Thickness: .2245" Fluorescence: pale yellow on one side Refractive index: C - 1.5160, D - 1.5187 F - 1.5258
975	Refractive index: between 1.514 - 1.516 A is less dense than B. A is darker blue green in color than B, similar thickness.	Refractive index: between 1.516 - 1.518

	Sample A	Sample B
978	$N_c = 1.5154$, $N_d = 1.5183$, $N_f = 1.5255$ $N_f - N_c = .0101$ Density: 2.4767 @ 27.5°C	$N_c = 1.5182$, $N_d = 1.5212$, $N_f = 1.5282$ $N_f - N_c = .0100$ Density: 2.4956 @ 27.5°C
979	A is much less dense than B.	
980	Measurements were made on A and B for refractive index, density, fluorescence, and elemental composition.	
986	Refractive index: 1.5156 Thickness: 5.63 mm Density of A is less than B.	Refractive index: 1.5183 Thickness: 5.71 mm
987	Gradient density - different densities.	
989	Composition, density, and refractive index of A and B.	
994	A is less dense than B (significantly).	
995	Thickness: .223 inches Refractive index(refractometer) 1.5149 Refractive index(hot stage) 1.5150 A is less dense than B.	Thickness: .223 inches Refractive index(refractometer) 1.5180 Refractive index(hot stage) 1.5181
999	Color (tint) Thickness Density gradient Refractive index: 1.522 at rm temp	Color (tint) Thickness Density gradient Refractive index: 1.522 at rm temp

Table 8

RESPONSES TO QUESTION 3: Methods and instruments used.

705
1) Refractive index (Microscopic) three monocromatic wavelengths - 700, 590, 490.
2) Dispersion staining.
3) X-ray fluorscence.

709
1) UV short wave light.

712
1) UV short wave light.
2) Thickness with calipers.
3) Refractive index using a monochromator, hot stage, stereo zoom microscope and Cargille liquids 1.520, 1.518, and 1.516. Measurements made by temperature variation at the D line.

713
1) Thickness by micrometer.
2) Refractive index using polarizing microscope and Cargille liquids.

717
1) Thickness by calipers.
2) Relative density with mixture of Methylene Iodine and Bromobenzene.
3) Refractive index using Cargille liquids, hot stage and Becke line phenomena.
4) Spectrographic analyses.

718
1) Density gradient columns with mixture of bromobenzene and bromoform.
2) Refractive index using Cargille liquids, Becke line by Sodium lamp, hot stage, and microscope.

719
1) Microscopy
2) X-ray fluorescence.

722
1) Refractive index using microscope, Sodium light, Cargille liquids.
2) Density gradient using tubes and liquids.
3) UV short wave light.

726
1) Refractive index using Cargille liquids.
2) Density by comparative flotation method.
3) UV short wave light.
4) Emission spectrograph.

727
1) Refractive index using a microscope, monochromator, hot stage.
2) Sink float density method using mixture of bromoform and MeOH.

729
1) UV short wave light.

730
1) UV - Vis. continuous scan (800nm to 310nm).
2) Emission spectrograph.

731
1) Visual examination - color & thickness.
2) Physical edge match.
3) Density gradient.

739
1) Refractive index using microscopes (ordinary & polarizing), Cargille oils.
2) Density gradient tubes with mixture of bromobenzene and bromoform.
3) Thickness.

740
1) Refractive index by refractometer.
2) Dispersive X-ray.

742
1) Thickness by thickness gauge.
2) UV short wave light.
3) Refractive index by Emmons double variation method using polarizing microscope, hot stage, monochromator, and silicone oil.
4) Emission spectrograph.

745
1) Density by tube flotation with mixture of bromoform and bromobenzene.
2) Refractive index using Cargille liquids, Becke line, and interference filters (489, 585, and 667 nm).
3) Thickness with vernier calipers.

746
1) Refractive index using microscope, Cargille liquids.
2) Density comparison using mixture of bromoform and bromobenzene.

747
1) Thickness by gauge.
2) Refractive index using refractometer.
3) Dispersion by Emmons Double Variation Method using contrast microscope, hot stage and monochromator.

748
1) UV short wave light.
2) Thickness by micrometer calipers.
3) Density by macro method using water and analytical balance.

750
1) UV lamp.
2) Sink-float comparison with mixture of monobromo benzene and bromoform.
3) Refractive index using monochromator, mixture of xylene and monobromo benzene.

751
1) Birefrengence and micro appearance by polarizing microscope.
2) Thickness by direct reading gauge.
3) UV short and long wave lights.
4) Refractive index using refractometer.
5) Dispersion and refractive index by Emmons double variation method using microscope, hot stage, and monochromator and Cargille liquids.

752
1) Sink-float density method with solution of mercuric potassium iodide.
2) Refractive index using microscope, silicone fluid, hot stage and optical interference filter.

754
1) Visual examination for color.
2) UV short wave light.
3) Gradient density with commercial oils of 2.80 - 2.20
4) Refractive index using microscope, monochromator, hot stage, and silicone oil.

756
1) Thickness by micrometer.
2) Refractive index and dispersion by Emmons double variation method using microscope, hot stage, monochromator, and Cargille liquids.

757
1) UV light.

760
1) UV light.
2) Thickness using micrometer.
3) Refractive index using Cargille liquids, white light source and Becke line.
4) Sink-float density comparison using mixture of bromoform and ethanol.

762
1) Thickness by micrometer.
2) Density with mixture of liquids.
3) Refractive index using monochromator, microscope, controlled temperature water bath and artified index of refraction liquids set.

763
1) Refractive index using Cargille liquids.
2) Float-sink comparison using CBr_4/CHC_3 mixture.

765
1) Thickness by micrometer.
2) UV scan by spectrophotometer.
3) Refractive index by refractometer.
4) Density by benzene and bromoform mixture.

766
1) Refractive index by refractometer.
2) Density gradient tube comparison.
3) Melting point apparatus.

768
1) UV short wave light.

769
1) Thickness by caliper and micrometer.
2) Specific gravity and density using analytical balance and water displacement method.
3) Refractive index by refractometer.
4) Physical jigsaw match.
5) Density using bromoform and bromobenzene mixture.
6) UV short wave light.
7) Spectrofluorometric analysis using a spectrofluorometer.
8) Emission spectrograph for spectrographic analysis.

773
1) UV short wave light.
2) Density determination using bromoform and EtOH.

777
1) Thickness by micrometer.
2) Refractive index by refractometer.
3) Analytical balance.

778
1) Refractive index using hot stage and silicone oil.
2) X-Ray fluorescence.

779
1) Refractive index using Cargille liquids and hot stage.
2) Density by comparison using methylene iodide and bromobenzene.

783
1) Thickness by dial micrometer.
2) Refractive index by refractometer.

784
1) Density gradient using bromoform and bromobenzene.
2) Refractive index using Cargille liquids.
3) Elemental composition by X-Ray fluorescence.
4) Thickness using micrometer.

786
1) UV fluorescence using Chromato-Vue instrument.
2) Elemental analysis using emission spectrograph.
3) Density using gradient columns.

787
1) Physical jigsaw match.
2) Gradient density method.

789
1) Refractive index using Cargille liquids, microscope, and 440mu filter.
2) Sink-float density method using $KHgI_3$.

790
1) Thickness using micrometer.
2) Density comparison using bromoform and bromobenzene.
3) Refractive index using contrast microscope, hot stage, silicone oils, spectrometer filters.

792
1) Refractive index using polarizing microscope with a phase contrast condenser and monochromatic filter.

794
1) UV light.
2) Thickness using micrometer.
3) Refractive index using refractometer.
4) Verification of glass samples using polarizing microscope.

796
1) Thickness using micrometer.
2) Specific gravity using analytical balance, water and tergitol.
3) Elemental analysis calculated to oxides - SEM + EDXA.

797
1) Refractive index using refractometer.
2) Refractive index by Emmons Double Variation Method using monochromator compound microscope, hot stage and Cargille liquids.

798
1) UV light.
2) Refractive index using microscope and Cargille liquids.
3) Gradient density using bromoform and bromobenzene mixtures.

799
1) UV, IR, and normal illumination.
2) Microscopic observation by stereo microscope.
3) Refractive index using refractometer and hot stage.
4) Thickness using micrometer.
5) Comparative density gradient and absolute density by Pycnometer.
6) Emission spectrograph.

805
1) Thickness by micrometer.
2) Flotation density using mixture bromoform-bromobenzene.
3) Dispersion staining.
4) Emission spectrograph.

806
1) Thickness using calipers.
2) Edge color comparison against white background.
3) Specific gravity using Mercuric potassium iodide solution.
4) Refractive index using microscope, hot stage, silicone oil, and sodium filter.

809
1) Thickness by micrometer.
2) Density gradient using bromoform-bromobenzine mixture.
3) Emission spectrograph.

813
1) Density using bromoform-bromobenzine mixture.
2) X-Ray fluorescence.
3) Dispersion staining using McCrone objective with Cargille oils.

815
1) Visual color using north light.
2) Thickness using micrometer.
3) Refractive index using Cargille liquids and 593nm interference filter.
4) Dispersion staining.

818
1) Sink-float density method.
2) Thermal gradient apparatus.

820
1) UV light.
2) Refractive index using refractometer.

821
1) Thickness using caliper.
2) Density gradient column.
3) Refractive index using microscope with narrow-band pass filters.

822
1) Micrometer.
2) Spectrophotometer.
3) Polarizer.

823
1) Refractive index using polarizing microscope, Cargille liquids, and three wavelength filters.

827
1) Refractive index and dispersion using refractometer.
2) Emission spectrograph.
3) Density gradient tube with bromoform and bromobenzene mixture.
4) UV lamp and fluorometer.
5) Thickness using caliper.

829
1) Refractive index using microscope with R & G filters, Cargille liquids, and hot stage.
2) Oil emersion - double variation method.

831
1) Mixture of 1, 1, 2, 2, tetrabromoethane and ethyl alcohol.

832
1) Density gradient tube with oils (3.0 to 2.2).

833
1) Refractive index using refractometer.
2) UV-visible on recording spectrophotometer.
3) Thickness using micrometer.
4) Density gradient using bromoform-bromobenzene mixtures.
5) UV short wave and long wave lights.
6) Fluorescence spectrum using fluorescence spectrometer.

835
1) Specific gravity using bromoform-bromobenzene mixture.
2) Refractive index using microscope and Cargille liquids.
3) Spectrograph.

837
1) Thickness using caliper.
2) UV light.
3) Dispersion characteristics using microscope, monochromator, and hot stage.

838
1) Refractive index using refractometer.

839
1) Thickness.
2) Refractive index using Cargille liquids.
3) X-Ray fluorescence spectrometer.

842
1) Refractive index.
2) Density gradient.
3) Floatation.

843
1) Density by pycnometer.
2) Time of flight using ultrasonic time of flight measurement instrument.

847
1) Refractive index and dispersion using microscope, monochrometer, Cargille liquids, and hot stage.
2) Thickness using micrometer.
3) Sink-float density comparison using bromoform and nitrobenzene.

848
1) Refractive index using microscope, hot stage, silicone oil, and sodium light.

849
1) Visual.
2) Micrometer.
3) Refractometer.

852
1) Refractive index and dispersion using microscope, monochromator, Cargille liquids, and hot stage.
2) Thickness using micrometer.
3) Sink-float density comparison using bromoform and nitrobenzene.

853
1) Density gradient.
2) Refractometer.

854
1) X-Ray fluorescence.
2) UV short wave light.

855
1) Thickness using micrometer.
2) Comparative density using bromoform and bromobenzene.
3) Refractive index using liquids and hot stage.
4) Dispersion checked by repeating RI procedure at two other wave lengths.

856
1) Thickness using a paper gauge.
2) UV light.
3) Density using sink-float method with bromobenzene and methylene iodide.
4) Refractive index using microscope and Cargille liquids.

863
1) Refractometer.
2) Micrometer.

866
1) Refractive index using refractometer.
2) Density floatation method using bromoform and bromobenzene mixture.

868
1) Refractive index using Cargille liquids and 3 wavelength filters.

872
1) Density floatation method using bromoform-bromobenzene mixture.
2) Refractive index using hot stage, silicone oil, and 3 light filters.
3) Emission spectrographic composition.

873
1) Refractive index using refractometer.
2) Floatation method for comparative specific gravity.

874
1) UV light.
2) Bromoform-bromobenzene mixture.

876
1) Diameter using micrometer.
2) Refractive index using Cargille liquids and band pass filters.
3) Density column using bromobenzene-bromoform.

880
1) Visual observation.
2) UV Light.
3) X-Ray spectrometer.
4) Rough density gradient.
5) Rough refractive index.
6) Dispersion curves using hot stage and optical wedge.

883
1) UV light.
2) Refractive index by silicone oil and Dabbs and Pearson method.

884
1) Thickness using calipers.
2) Floatation method for density.

885
1) Thickness.
2) UV light.
3) Infra-red spectrophotometric analysis.
4) Differential infra-red spectrophotometric analysis.
5) X-Ray fluorescence.

888
1) Thickness using micrometer.
2) Refractive index using polarizing microscope, hot stage, monochromator, and Cargille liquids.
3) Data plotted on dispersion graph paper.

889
1) UV light.
2) Refractive index using refractometer.

892
1) Density gradient using bromoform-bromobenzene mixture.
2) Elemental analysis using spectrographic analyzer.
3) Refractive index using photomicroscope, hot stage, Cargille liquids, and red filter.

894
1) Density gradient using benzene and bromoform.
2) Refractive index using Cargille liquids and hot stage.

895
1) Density.

897
1) Thickness using micrometer.
2) Refractive index using refractometer.
3) UV light.
4) Density gradient tubes.

899
1) Micrometer.
2) Refractive index using refractometer.
3) UV short and long wave lamps.

907
1) X-Ray fluorescence.
2) Dispersion staining.
3) Refractive index.
4) Density gradient.

908
1) UV light.
2) Refractive index using Cargille liquids.
3) Visible color.
4) Comparative density using two mixtures bromoform-xylene and bromoform-ethanol.

915
1) Thickness using micrometer.
2) UV short wave light.
3) Refractive index and dispersion using Emmons Double Variation Method with hot stages, microscope, monochrometer, and Cargille liquids.

921
1) Refractive index using refractometer.
2) Comparative density using bromoform and bromobenzene.
3) Emission spectrum.

923
1) Thickness using micrometer.
2) Density column.
3) Becke line using microscope.
4) Phase contrast microscopy with temperature variation.
5) Dispersion staining objective and hot stage with monochromator.

925
1) Refractive index using contrast microscope with microfurnace and optical filters.
2) Density according to Greene and Burd method.

926
1) Thickness by micrometer.
2) Floatation method for relative density.

931
1) Refractive index using polarizing microscope, phase microscope, microfurnace, and narrow band interference filters.

938
1) Refractive index using Cargille liquids and hot stage.
2) Density using bromoform-bromobenzene, and 25ml pycnometer.

944
1) Density gradient.

948
No listing given.

958
1) Color by stereo microscope.
2) Thickness using micrometer.
3) Physical matching of edges.
4) Refractive index using refractometer and microscope with Cargille liquids.
5) Density gradient using bromoform-bromobenzene mixtures.

960
1) Refractive index using microscope and Cargille liquids.
2) X-ray spectrum.
3) Density column using methylene iodide and bromoethane.
4) UV light.

961
1) UV light.
2) Density by sink-float method using bromoform and mono-bromobenzene.
3) Refractive index using microscope, color filters and mixtures of benzyl alcohol and di-n-butylphthalate.

962
1) Emmons double variation method using microscope, hot stage, monochromator, and silicone oil.

969
1) UV lamp.

970
No listing given.

974
1) Density by sink-float method using bromoform and alcohol mixture.
2) UV short wave light.
3) Refractive index using microscope, hot stage, monochromator, silicone oil and dispersion graph paper.

975
1) Density comparison using tetrabromoethane and tetrachloride mixture.
2) Refractive index using microscope and Cargille liquids.

978
1) Refractive index by refractometer, microscope, monochromator, and hot stage.
2) Density by buoyancy method using balance.
3) UV short wave instrument.

979
1) Physical measurements.
2) Density.
3) Optical density.

980
1) Refractive index using refractometer.
2) Density gradient method.
3) Elemental composition using emission spectroscopy.
4) UV radiation.

986
1) Refractive index using refractometer.
2) Thickness using micrometer calipers.
3) Density gradient tubes.

987
1) Density gradient tubes using bromobenzene and bromoform.

989
1) Emission spectrometer.
2) Density.
3) Refractive index using Cargille liquids.

994
1) Density using bromoform and benzene mixtures.

995
1) Refractive index using refractometer.
2) Refractive index using hot stage, silicone oil, and Pearson and Dobbs method.
3) Comparative density using bromobenzene and tetrabromoethane.

999
1) Visual for color.
2) Thickness using calipers.
3) Density gradient using tubes with a variety of liquids.
4) Refractive index using Cargille liquids and a microscope.

Table 9

METHODS

Lab Code	Color	Density	Dispersion Curves	Dispersion Staining	Elemental Analysis	Physical Edge Match	Refractive Index	Thickness	U.V. Light	X-ray fluorescence	Other
705				X			X			X	
709									X		
712							X	X	X		
713							X	X			
717		X			X		X	X			
718		X					X				
719										X	Microscopy
722		X					X		X		
726		X			X		X		X		
727		X					X				
729									X		
730					X				X		Visible scan
731	X	X				X		X			
739		X					X	X			
740							X				Dispersive X-ray
742					X		X	X	X		
745		X					X	X			
746		X					X				
747			X				X	X			
748		X						X	X		
750		X					X		X		
751			X				X	X	X		Birefringence
752		X					X				

Lab Code	Color	Density	Dispersion Curves	Dispersion Staining	Elemental Analysis	Physical Edge Match	Refractive Index	Thickness	U.V. Light	X-ray Fluorescence	Other
754	X	X					X		X		
756							X	X			
757									X		
760		X					X	X	X		
762		X					X	X			
763		X					X				
765		X					X	X	X		
766		X					X				
768									X		
769		X			X	X	X	X	X		Specific gravity Spectrofluorometric anal sis
773		X							X		
777			X				X	X			
778							X			X	
779		X					X				
783							X	X			
784		X			X		X	X			
786		X			X				X		
787		X				X					
789		X					X				
790		X					X	X			
792							X				
794							X	X	X		Verification of glass using polarizing microsco
796					X			X			Specific gravity
797			X				X				
798		X					X		X		
799		X			X		X	X	X		IR and normal illumination
805		X		X	X			X			

Lab Code	Color	Density	Dispersion Curves	Dispersion Staining	Elemental Analysis	Physical Edge Match	Refractive Index	Thickness	U.V. Light	X-ray Fluorescence	Other
806	X						X	X			Specific gravity
809		X			X			X			
813		X		X						X	
815	X			X			X	X			
818							X		X		
820							X		X		
821		X					X	X			
822								X			Spectrophotometer, polarizer
823								X			
827		X			X		X	X	X		
829			X				X				
831		X									
832		X									
833		X					X	X	X		visible scan, fluorescence spectrometer
835					X		X				specific gravity
837			X					X	X		
838							X				
839							X	X		X	
842		X					X				
843		X									ultrasonic time of flight measurement instrument
847		X					X	X			
848							X				
849	X						X	X			
852		X	X				X	X			
853		X					X				
854									X	X	

Lab Code	Color	Density	Dispersion Curves	Dispersion Staining	Elemental Analysis	Physical Edge Match	Refractive Index	Thickness	U.V. Light	X-ray Fluorescence	Other
855		X	X				X	X			
856		X					X	X	X		
863							X	X			
866		X					X				
868							X				
872		X			X		X				
873		X					X				
874		X							X		
876		X					X	X			
880	X	X	X				X		X		X-ray spectrometer
883							X		X		
884		X						X			
885								X	X	X	Infra-red spectro analysis differential infrared anal sis
888			X				X	X			
889							X		X		
892		X			X		X				
894		X					X				
895		X									
897		X					X	X	X		
899							X	X	X		
907		X		X			X			X	
908	X	X					X		X		
915			X				X	X	X		
921		X			X		X				
923		X		X			X	X			phase contrast microscopy
925		X					X				

Lab Code	Color	Density	Dispersion Curves	Dispersion Staining	Elemental Analysis	Physical Edge Match	Refractive Index	Thickness	U.V. Light	X-ray Fluorescence	Other
926		X						X			
931							X				
938		X					X				
944		X									
948											
958	X	X				X	X	X			
960		X					X		X		X-ray spectrum
961		X					X		X		
962			X				X				
969									X		
970											
974		X	X				X		X		
975		X					X				
978		X					X		X		
979		X									physical measurement
980		X			X		X		X		
986		X					X	X			
987		X									
989		X			X		X				
994		X									
995		X	X				X				
999	X	X					X	X			

END