LABORATORY PROFICIENCY TESTING PROGRAM

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PROFICIENCY TESTING

THE FORENSIC SCIENCES FOUNDATION, INC.
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LABORATORY PROFICIENCY TESTING PROGRAM

REPORT NO. 12

FIBER EXAMINATION

Statistical presentations prepared by:

COLLABORATIVE TESTING SERVICES, INC.
Vienna, Virginia

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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 twelfth 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 different samples of physical evidence similar in nature to the types of evidence normally submitted to them for analysis.

The results for Test Number Twelve 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.

April 1976

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BACKGROUND

This laboratory proficiency testing research project, one phase 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 238 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".

Additional evaluations of individual tests will be published in a separate report.

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 Collaborative Testing Systems, Inc. in the areas of statistical presentation.

SUMMARY

Sample #12 consisted of fiber samples A, B, and C packaged in glassine envelopes. They were mailed on January 6, 1976 with instructions to handle the samples in a manner similar to like evidence submitted for analysis.

In this test, 238 laboratories were sent three fiber samples which were referred to as Items A, B, and C. Participants were asked three questions: (1) Could Items A or B have common origin with Item C? (2) What information did you develop to arrive at your conclusions in Question 1? (3) What methods and instruments were used?

Of the 238 laboratories, 42 indicated that they do not do fiber analysis, 79 did not respond, and 116 responded with data. This represents a participation rate of 61%. One laboratory responded too late to be included in this report. Table 1 listed the codes for laboratories in each of the first two categories above.

The information in Table 2 shows that Items A and B were not of common origin with Item C. Table 3 contains the responses of the referee laboratories. Table 4 summarizes the responses given for Question 1. Table 5 lists the frequency of reported methods given in the response to Question 2. The eight most frequently used methods are tabulated in Tables 6a and 6b. Table 6c tabulates the steps of the fiber analysis in which each of the eight most frequently used methods was performed. Tables 6d and 6e contain information pertaining to the points at which conclusions were reached. Tables 7a and 7b tabulate the results of Melting Point Determination and Refractive Index studies by the laboratories. Finally, Table 8 is a summary of the methods used and the results of the methods used by each laboratory in lab code order.

No effort was made in the report to highlight areas wherein laboratory improvements might be instigated.

ANNEX A

LAB CODE B _____

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

DATE RECEIVED IN LAB _____

DATE PROCESSED IN LAB _____

DATA SHEET
PROFICIENCY TESTING PROGRAM

TEST #12
FIBER EXAMINATION

Item C represents fibers from the scene of a homicide. Items A and B represent fibers found on the shoes of two different suspects.

1. Could Items A or B have common origin with C?

	ITEM A	ITEM B
YES	☐	☐
NO	☐	☐
INCONCLUSIVE	☐	☐

2. What information (qualitative and quantitative) did you develop to arrive at your conclusions in Question 1? Please check all appropriate boxes and provide values where applicable.

In the left hand column indicate the sequence (1, 2, 3, etc.) in which the tests were run. Indicate with an asterisk (*) the point where a conclusion was reached, even though subsequent tests were performed for confirmatory purposes.

Sequence of Testing		ITEM A	ITEM B	ITEM C
_____	BIREFRINGENCE			
_____	EMISSION SPECTROSCOPY (Specify Elements Identified)			
_____	FLUORESCENT STUDIES			
_____	INFRARED ANALYSIS			
_____	MACROSCOPIC EXAMINATION			
_____	MELTING POINT DETERMINATION			
_____	MICROSCOPIC EXAMINATION (Specify Type)			
_____	PYROLYSIS G-C			
_____	REFRACTIVE INDEX			
_____	SOLUBILITY TESTS (Specify Solvents Used)			
_____	THIN LAYER CHROMATOGRAPHY			
_____	UV SPECTROPHOTOMETRY			
_____	X-RAY DIFFRACTION			
_____	X-RAY FLUORESCENCE (Count Ratio)			
_____	OTHER (SPECIFY) _____			
_____	_____			
_____	_____			

3. Please specify the information developed with each of the methods and instruments checked in Question 2. (Example: Solubility tests using HCl, H_2SO_4, Acetone and HNO_3; microscopic-fibers identified as cotton, nylon, etc.)

   Please provide specific and complete responses. Attach additional sheets if necessary.

   Method:

   Method:

   Method:

4. Additional Comments:

DATA SHEETS MUST BE RECEIVED AT THE
FOUNDATION OFFICE BY FEBRUARY 10, 1976

Table 1

Code Numbers of Non-participating Laboratories

THE FOLLOWING LABORATORIES INDICATED THEY DO NOT DO FIBER ANALYSIS

208	316	391	427
221	326	392	439
229	333	399	459
239	338	400	460
259	342	402	469
270	372	404	471
276	377	409	477
298	378	416	480
300	386	417	484
301	390	421	496
			497
			1000

Total Labs = 42

THE FOLLOWING LABORATORIES DID NOT RESPOND

207	294	352	413	489
213	296	354	414	494
223	299	355	415	495
224	302	360	419	
226	304	363	420	
228	307	366	423	
233	308	367	434	
240	311	368	435	
243	312	369	440	
255	327	373	441	
268	335	374	448	
275	336	381	454	
279	339	389	458	
280	343	393	467	
281	344	395	475	
283	346	396	481	
284	348	401	483	
290	349	403	485	
292	350	407	486	

Total Labs = 79

Table 2

Supplier's Characterization of Samples

Item A	100% wool	Philadelphia Carpet Company
	Color:	Heather Green
Item B	Acrylic	(70% acrylic + 30% modacrylic) Brinkcrest Company
	Color:	#1014 Avocado
Item C	100% Dacron Polyester	Burlington Industries
	Color:	#31 Pine

Table 3

RESULTS OF THE REFEREE LABORATORIES

Referee Laboratory 1

1. Response to Question 1:

   Could Items A or B have common origin with Item C?

   Item A - NO

   Item B - NO

2. Response to Question 2:

   What information did you develop to arrive at your conclusions in Question 1?

Sequence of Testing	Test	Item A	Item B	Item C
1	Macroscopic Examination			
*2	Microscopic Examination	Wool	Synthetic	Synthetic
3	Sign of Elongation		-	+
*4	Solubility Tests		Soluble in 20% H_2SO_4+ Dimethyl-formamide Identified B	Not Soluble
5	Refractive Index		n_ε 1.514-1.516 n_ω 1.514-1.516	n_ε 1.552
*6	Infrared Analysis			Identified C

Note: Microscopic Examination showed a difference between A, B & C and the following battery of tests was to identify B & C.

Table 3, continued

Referee Laboratory 2

1. Response to Question 1:

   Could Items A or B have common origin with Item C?

   Item A - NO

   Item B - NO

2. Response to Question 2:

   What information did you develop to arrive at your conclusions in Question 1?

   1. Stereoscopic Examination at 10X: Differences in color and crimp of fibers noted between A, B and C.

   2. Microscopic Examination at 200X mounted in R.I. 1.540 using polarizing microscope:

      Sample A: pale yellow-green color
      scales are visible
      refractive indicies of fiber in area of 1.540

      Sample B: almost colorless
      smooth surface, no delusterant visible
      flat ribbon-like appearance
      both $n_{//}$ and $n_{\perp}$ below 1.540

      Sample C: yellow-green in color
      smooth surface, no delusterant visible
      appears to be trilobal
      both $n_{//}$ and $n_{\perp}$ above 1.540

   3. Birefringence using polarizing microscope at 200X:

      Sample B: negative birefringence
      1st order grey

      Sample C: positive birefringence
      3rd order yellow-orange

   4. Refractive Index using certified Cargille liquids and polarizing microscope at 200X:

      Sample B: $n_{//}$ = 1.512, $n_{\perp}$ = 1.515 (possible acrylic fibers)
      Birefringence = -0.0003

      Sample C: $n_{//}$ = 1.693, $n_{\perp}$ = 1.555 (possible polyester fibers)
      Birefringence = +0.138

Table 3, continued

5. Scale cast using clear nail polish:acetone (1:1)

   Sample A: A is dyed animal fibers
   exact animal cannot be given due to stripping and dying of fibers, however, a type of wool is suspected

6. Cross-sections using Hardy microtome:

   Sample B: "dog-bone" cross section
   sample very likely Orlon acrylic

   Sample C: triangular cross section
   reference literature in our possession reports only one polyester type with triangular cross-section as being Dacron T-62

7. Solubility Test:

   Sample B: fibers are not soluble in cold dimethylformamide
   fibers are soluble in boiling dimethylformamide
   Sample B confirmed as being Orlon acrylic fibers

8. Melting point using polarizing microscope at 100X and Mettler Microfurnace:

   Sample C: (in air) 254.0 to 259.8 C
   confirmed as being polyester fibers

Table 4

SUMMARY OF RESPONSES TO QUESTION 1

Question 1: Could Items A or B have common origin with Item C?

Response	Item A Same as Item C	% of Total Labs	Item B Same as Item C	% of Total Labs
Yes	0	0%	2	1.7%
No	116	100%	114	98.3%

Response	No. of Labs	% of Total Labs
Yes for both A and B	0	0 %
Yes for A and No for B	0	0%
No for A and Yes for B	2	1.7%
No for both A and B	114	98.3%
	116	100 %

Table 5

FREQUENCY OF THE REPORTED METHODS USED TO ANSWER QUESTION 2

Question 2: What information did you develop to arrive at your conclusions?

Method	Number of Reported Use of this Method	Percentage of Responding Labs Using this Method
Microscopic Examination	121*	N/A*
Macroscopic Examination	84	71.8%
Solubility Test	55	48.2%
Birefringence	46	40.4%
Melting Point Determination	20	17.1%
Refractive Index	19	16.7%
Fluorescent Studies	13	11.1%
Infrared Analysis	10	9.4%
Flame Test	2	1.7%
Density Studies	1	.9%
Thin-layer Chromatography	1	.9%
Dupont I.D. Stain #4	1	.9%
Thermal Depolarization Analysis	1	.9%
Color Test	1	.9%
UV Spectrophotometry	1	.9%
Diameter of Fibers	1	.9%

*Some Laboratories reported more than one microscopic examination in response to Question 2. 113 different Labs did some kind of microscopic examination

Table 6a

Comparison of Items A and C by the Eight Most Frequently Reported Methods

Method	Number of Labs Comparing Item A and Item C by this Method	Number of Labs Reporting they Could Differentiate Item A from Item C by this Method	Number of Labs Reporting they Could Not Differentiate Item A from Item C by this Method
Microscopic Exam	108	108	0
Macroscopic Exam	56	38	18
Solubility Tests	26	22	4
Birefringence	22	19	3
Melting Point Determination	10	10	0
Refractive Index	4	4	0
Fluorescent Studies	8	3	5
Infrared Analysis	3	2	1

Table 6b
Comparison of Items B and C by
the Eight Most Frequently Reported Methods

Method	Number of Labs Comparing Item B and Item C by this Method	Number of Labs Reporting they Could Differentiate Item B from Item C by this Method	Number of Labs Reporting they Could Not Differentiate Item B from Item C by this Method
Microscopic Exam	107	99	8
Macroscopic Exam	56	20	36
Solubility Tests	45	39	6
Birefringence	36	33	3
Melting Point Determination	19	19	0
Refractive Index	16	16	0
Fluorescent Studies	10	5	5
Infrared Analysis	9	9	0

Table 6c

Numerical and Sequential Breakdown
of the Eight Most Frequently Reported Methods

Method	Number of Labs Using this Method	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
Microscopic Examination	121*	30	79	8	2	0	1	0	1
Macroscopic Examination	83	80	3	0	0	0	0	0	0
Solubility Tests	55	0	9	26	13	5	2	0	0
Birefringence	46	2	12	17	10	3	2	0	0
Melting Point Determination	20	0	1	7	6	3	2	1	0
Refractive Index	19	0	1	6	7	5	0	0	0
Fluorescent Studies	13	1	5	4	3	0	0	0	0
Infrared Analysis	10	1	1	4	2	1	0	1	0

*Some Labs reported more than one microscopic examination.

Table 6d

Number of Tests Performed to Reach a Conclusion

Step	Number of Conclusions Reached at this Step
1	20
2	71
3	16
4	5
5	1
6	1

Note: 15 Labs did not report the point where a conclusion was reached (i.e., no * shown)
Also, some Labs reported more than one asterisk

Table 6e

Number of Conclusions Reached from Each of the Eight Most Frequently Used Methods

Method	Number of Conclusions Reached on this Method
Microscopic Examination	79
Macroscopic Examination	6
Solubility Tests	7
Birefringence	11
Melting Point Determination	3
Refractive Index	2
Fluorescent Studies	1
Infrared Analysis	4

Table 7a

Melting Point Determination Results

Lab Code	Item A	Item B	Item C
215		Partially melts 180°-190° C Remainder above 270°C	220-230°C
218	A and B indeterminate		260°C
227		Softening at 225°C does not melt	250°C
248	Chars at 225°C	Chars at 275°C	Melts at 225°C
252	Indeterminate	Indeterminate	257°C
254	A and B indeterminate		235°C
266	Decomposes	233°C	238°C
271		Indeterminate	253.9°C
273		Chars up to 291.7°C	253.1°C
277		No melting; chars	200°C
282	Indeterminate	Indeterminate	257.5± .5°C
324		Greater than 260°C	258°C
405		Shrinkage 153°- 155°C	251°- 252°C
406		Indeterminate	250°- 252°C
430	Charred	Charred	Melted
436	None	None	258°C
444	None	None	250°C
462		Indeterminate	250°C
482	A, B, C different		

Table 7b

Refractive Index Results

Lab Code	Item A	Item B	Item C
227		C has greater refractive index than B	
269			$n_{\parallel} > 1.67$
271		1.515 - $n_{\parallel}$	1.697 - $n_{\parallel}$
		1.515 - $n_{\perp}$	1.553 - $n_{\perp}$
282	1.556 - 1.560	1.517	Greater than 1.700
285		Both indices of B less than C	
314		Qualitative difference between B and C with immersion oil	
320		greater than 1.502	
353			
380		n_{ε} , $n_{\omega} \approx 1.51$	n_{ε} Greater than 1.70
384		n_E 1.51 - 1.53	n_E Greater than 1.66
385		B and C different	
405	$n_{\parallel}$ 1.56	$n_{\parallel}$ 1.532 $n_{\perp}$ 1.532	$n_{\parallel}$ 1.705 $n_{\perp}$ 1.552
444		N=1.53 & 1.52	N=1.69 N=1.55
445			$n_{\parallel} = 1.700$
446	1.560	1.510	1.718 parallel 1.534 perpendicular
450	parallel 1.557 perpendicular 1.547	1.51 and 1.54	Parallel near 1.7
453		$n_{\perp}$ and $n_{\parallel}$ below 1.6	$n_{\parallel}$ higher than 1.6 $n_{\perp}$ lower than 1.6
455		$n_{\parallel}$ and $n_{\perp} \approx$ 1.54	$n_{\parallel}$ 1.71 $n_{\perp}$ 1.55
277			length greater than 1.568 width less than 1.568

Table 8

Detailed Summary of Laboratory Responses

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
201	1	Macroscopic Exam			
NN	2*	Microscopic Exam	Hair of animal origin	Mixture of dull & bright synthetic fibers	Bright synthetic fiber
202	1	Macroscopic Exam			
NN	2*	Microscopic Exam			
	3	Solubility Tests			
205	1	Macroscopic Exam			
NN	2*	Microscopic Exam			
209	1	Birefringence	Yes	No	No
NN	2*	Microscopic Exam	Animal hair wool	Two varieties of synthetic fiber; one with delusterizing agent; one with dumb bell	One type of synthetic; trilobular cross-section
	3	Pyrolysis GC		B different from C	
210	1	Macroscopic Exam			
NN	2*	Microscopic Exam			
211	1	Macroscopic Exam		A ≠ B ≠ C	
NN	2	Density		B > A > C	
	3	Microscopic Exam		A ≠ B ≠ C	
	4	Birefringence	Yes	Yes	No
212	1	Macroscopic Exam	Lighter green than B & C	Compares w/C	Compares w/B
NY	2	Microscopic Exam	Does not compare with B & C		Only one fiber
				Synthetic	compares w/B
	3	Solubility Tests		Compares with C	Compares w/B
	4	Birefringence			
	5	Pyrolysis G-C		Compares w/C	Compares w/B
214	1	Macroscopic Exam			
NN	2	Microscopic Exam	Wool	Synthetic difference from C	Synthetic difference from B
	3	Solubility Tests		Dissolves in HNO_3	Doesn't dissolve in HNO_3
215	1	Macroscopic Exam	A different than B and C		
NN	2	Microscopic Exam	Animal fiber	B and C differ significantly	
	3	Melting Point Determination		Partially melts 180-190°C; completely above 270°C	220-235°C
216	1	Macroscopic Exam			
NN	2	Microscopic Exam	Hair	Color different from C	Color different from B
	3*	Infrared Analysis		Acrylic	Polyester

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
217 NN	1*	Microscopic Exam	Natural fiber	B&C synthetic	B different from C
	2	Birefringence		Elongation sign of B opposite that of C	
218 NN	1	Macroscopic Exam	Light yellow-green; medium luster	Light yellow-green; high luster	Light yellow; green; high luster
	2*	Microscopic Exam	Natural Animal Fiber	Synthetic	Synthetic
	3	Fluorescent Studies	Fluorescent	Fluorescent	Absorbs
	4	Melting Point Determination	A & B indeterminate		Approximately 260°C
	5	Solubility Tests	Insoluble	Soluble to Partial to Insoluble	Soluble to insoluble 5 reagents
	6	Microscopic Cross Section	Round	Dumb Bell Shaped	Irregular triangle
219 NN	1	Macroscopic Exam	Green, Many thin fibers	Green, short fibers; glistening	Green
	2	Microscopic Exam	A different from C	B different from C	
225 NN	1*	Microscopic Exam	Wool Fiber	Synthetic; two-types	Synthetic-Trilobal
	2	Birefringence		Low birefringence	High birefringence
	3	Infrared		1)acrylic 2)mod-acrylic	Pet Polyester
227 NN	1	Macroscopic Exam	A does not have the luster of B and C		
	2*	Microscopic Exam	A has scales, B and C did not.		
	3	Fluorescent Studies		Fluoreses green	Fluoreses yellow
	4*	Solubility Tests		Used ten solvents	
			B different from C in Nitric Acid		
	5	Refractive Index		C has greater refractive index than B	
	6	Birefringence		B and C are birefringent	
	7	Melting Point Determination		Softens at 225°C, does not melt	250°C
236 NM	1	Macroscopic Examination	Yellow	Yellow	Green
	2*	Microscopic Exam (stereo)	Medullated	Dog bone synthetic	Tri-lobal synthetic
	3	Microscopic Exam (polarizing)	Wool	(-) sign elongation	high birefringence
	4	Birefringence	Medium	Low	High
	5	Solubility Tests	Dye insoluble in aroclor	Dye insoluble in aroclor	Dye soluble in aroclor
237 NN	1	Macroscopic Exam	A, B, and C approximately the same		
	2*	Solubility Tests	Used four solvents, A, B, and C found to be different		
	3	Microscopic Exam	Almost transparent thickness= .025mm	Yellow-green thickness= .05mm	Yellow-green thickness= .03mm
	4	Birefringence	Low birefringence + optic sign	Low birefringence - optic sign	High birefringence + optic sign

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequen ce of Testing	Test	Item A	Item B	Item C
238 NN	1*	Microscopic Exam			
	2	Birefringence			
246 NN	1	Macroscopic Exam			
	2	Microscopic Exam			
247 NN	1*	Microscopic Exam	Wool	2 types noted - dogbone shape acrylic	1 type of Fiber Polyester
248 NN	1	Macroscopic Exam	clear to gray	B & C similar (greenish-yellow)	
	2	Microscopic Exam	animal origin (possibly wool)	man-made, with flattened conformation	man=made, rounder filament, (possibly nylon)
	3*	Birefringence	high bire-fringence negative elongation	slight bire-fringence positive elongation	birefringence plus-minus elongation
	4	Solubility Tests	A, B, and C insoluble in all seven reagents except for Nitric acid		
	5	Melting Point Determination	Chars at 225°C	Chars at 275°C	Melts at 225°C
249 NN	1	Microscopic Exam	Wool	Acrylic	Polyester
	2	Birefringence	Medium	Low	High
	3	Solubility Tests	Confirm microscopic examinations		
250 NN	1	Macroscopic Exam	A, B, and C have different colors		
	2*	Microscopic Exam	A, B, and C contain different fibers		
251 NN	1	Microscopic Exam	Animal origin	Dumb bell shape	Dumb bell shape
	2*	Birefringence	Yes	No	Yes
252 NN	1	Microscopic Exam	Round shaped, has scales	Dog-bone shaped	Trilobal shaped
	2	Solubility Tests	Soluble in Chlorox (Na OCl)	Sol. in H_2SO_4 Insol. in HCl	Sol.in H_2SO_4 Insol in HCl
	3*	Melting Point Determination	Indeterminate	Indeterminate	257°C
253 NN	1	Macroscopic Exam			
	2	Microscopic Exam			
	3	Fluorescent Studies			
	4	Solubility Tests			
254 NY	1	Microscopic Exam	Wool Round cross-section	Twisted dog-boned cross section	3 sides ball-shaped
	2	Flame Test	Smell of burnt hair, self-extinguishing	Fuses away from flame	Fuses away from flame
	3*	Solubility Test	Soluble in Na OCl	Sol. NH_4SCN, 75% H_2SO_4 Insol-HCl, CH_3COOH	Sol-cresol-M Insol-Acetic Acid
	4	Melting Point Determination	A and B indeterminate		Approx. 235°C

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
256	1	Macroscopic Exam	A, B, C grossly same color		
NN	2*	Microscopic Exam	Wool	Bilobed Synthetic 2 types	Trilobed synthetic
	3	Birefringence		sign (+) for 1st type sign (-) for 2nd type	Sign Indeterminent
257	1	Macroscopic Exam			
NN	2	Microscopic Exam	Wool	Acrylic (orlon)	Nylon
	3	Solubility Tests	Three reagents used		
	4	Pyrolysis G-C			
260	1*	Macroscopic Exam			
NN	2*	Microscopic Exam	Natural fiber	Difference between B & C in color, and in cross-section	
	3	Solubility Tests		No usable results	
261	1	Macroscopic Exam	A "lighter" than B or C		
NN	2*	Microscopic Exam	Wool		
	3*	Birefringence		Low order	High order
	4	Infrared Analysis		Acrylic	Polyester
262	1	Macroscopic Exam			
NN	2*	Microscopic Exam	Wool	3 components different from C	Polyester
	3	Thin-layer Chromatography			
	4	Pyrolysis GC		Acrylic & mod-acrylic	Polyester
	5	Birefringence			High order
266	1	Microscopic Exam (stereo)	light green	light green	dark green
NN	2*	Microscopic Exam (high-power)	small scales round	large ribbon	small round
	3	Melting Point Determination	Decompose	233°C	238°C
269	1	Macroscopic Exam			
NN	2*	Microscopic Exam	Wool	2 cross section	Trilobal
	3*	Birefringence	Normal for wool	Acrylic and mod-acrylic	High
	4	Refractive Index			Greater than 1.65 indicates polyester
271	1	Macroscopic Exam	A, B, C, light green		
NN	2*	Microscopic Exam	Rough surface, cross markings wool	Broad, no cross markings	Rod-like with smooth surface
	3	Solubility Tests	Insoluble in all reagents	Soluble at 200°F	All insoluble
	4	Refractive Index		1.515- $n_{\parallel}$	1.697- $n_{\parallel}$
				1.515- $n_{\perp}$	1.553- $n_{\perp}$
	5	Birefringence		0	-144
	6	Melting Point Deter.		Indeterminate	253.9°C
	7	DuPont I.D. Stain #4	Brown	Yellowish-orange	Orange
	8	Cross-Sections	Round	Dog-bone	Round

* indicates the poin t where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
273	1	Macroscopic Exam			
NN	2*	Microscopic Exam	Wool		
	3*	Melting Point Determination	Approx. 291.7°C chars only	Approx. 253.1°C	
274	1	Macroscopic Exam	A, B, C, different colors		
NN	2	Microscopic Exam	Round	Dog-bone	Trilobal
277	1	Macroscopic Exam			
NN	2	Microscopic Exam			
	3	Birefringence	Yes	Yes	Yes
	4	Solubility Tests	None	Insol. in Glacial Acetic	Insol. in Glacial Acetic
	5	Refractive Index	None	None	Length 1.568 Width 1.568
	6*	Melting Point Determination	None	No melting, chars	200°C
			Wool	Orlon	Nylon
278 NN	1*	Microscopic Exam	A, B, C all dissimilar		
282 NN	1	Macroscopic Exam	Light green, semidull luster No UV Fluorescence	Light Green, bright luster No UV. Fluorescence	Light green, bright luster, No UV Fluorescence
	2*	Microscopic Exam	Wool	Acrylic	Synthetic, but not acrylic
	3	Refractive Index	1.556-1.560	1.517	Greater than 1.700
	4	Solubility Tests	A, B, C tested with nine reagents		
			natural origin	acrylic	polyester
	5	Melting Point Determinant	Indeterminate	Indeterminate	257.5 ± 15°C
	6	Pyrolysis G-C	A, B, C different		
	7	Thermal Depolarization Analysis			Only C yielded a curve
285	1	Macroscopic Exam	A, B, C, light green		
NN	2	Microscopic Exam	Animal fiber	Synthetic-diameter greater than C	Synthetic-diameter less than B
	3*	Refractive Index		Both indices of B are less than C	
	4	Solubility Tests		Insoluble in m-cresol	Soluble in m-cresol
	5	Birefringence		Negative birefringence	Positive birefringence
291	1	Macroscopic Exam			
NN	2*	Microscopic Exam	Animal hair	synthetic	synthetic
	3	Cross Section		bi-lobed	tri-lobed
295	1*	Macroscopic Exam	Lighter in color than B&C	Color density between A&C	Has luster not present in A&B
NN	2	Microscopic Exam	Animal hair	dumb bell cross-section	crenulated perifery
	3	Microscopic-Compound	Nothing in addition to No. 2 above		
	4	Microscopic-Floures.	Green	Red	Absorbed
297	1*	Microscopic Exam	Animal fibers	Synthetic dumb-bell shaped	Synthetic triangular shaped
NN	2	Solubility Tests	Insoluble	Slowly dissolves in H_2SO_4	Rapidly dissolves in H_2SO_4
	3	Color Tests		Orange-Brown	No R_x

* indicates the point where a conclusion was reached.

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
303	1	Macroscopic Exam	Dissimilar to B and C		
NN	2*	Microscopic Exam	Wool	Mixture 1)Bifilament 2)Synthetics Acrylic/Spandex	Single type: nylon/polyester
	3	Solubility Tests			
	4	Flame/heat Tests	Wool	Mixture Acrylic/Spandex	
309	1	Macroscopic Exam	A, B, C green color		
NN	2*	Microscopic Exam	Wool	Synthetic dog-bone cross-section	Synthetic crenulated cross-section
	3	Solubility Tests		Acrylic-"Orlon"	Polyester-"Dacron Type 62"
310	1	Macroscopic Exam	A, B, C, basically similar		
NN	2*	Microscopic Exam	Wool	Wider than C	Different from B Similar to A
	3	Solubility Tests		B soluble in conc.-Nitric acid	Not soluble in Nitric acid
313	1*	Macroscopic Exam			C different from A and B
NN	2	Microscopic Exam	Animal origin	Synthetic	Synthetic
			B and C have different cross-sections		
	3	Birefringence		B and C have different birefringence	
314	1*	Microscopic Exam	Wool	Qualitative difference noted between B and C	
NN	2	Refractive Index		Qualitative difference between B and C with immersion oil	
	3	Solubility Tests			
315	1	Fluorescent Studies		A, B, C have no fluorescence	
NN	2	Macroscopic Exam		A, B, C have same color	
	3*	Microscopic Exam	Non-striated Optic sign (+)	Striated Optic sign (-)	Striated Optic sign (+)
	4	Birefringence (Mitchell Levi Chart)	.013	.006	.1
317	1	Macroscopic Exam	A, B, C colors similar		
NN	2*	Microscopic Exam	Wool	Synthetic B and C different	Synthetic
319	1	Macroscopic Examination		C different color from A and B	
NN	2*	Microscopic Exam	Animal hair, perhaps wool	B is bilobal, different than C	
	3*	Solubility Tests	In soluble in H_2SO_4	Soluble in H_2SO_4 with no resulting color	Soluble in H_2SO_4 with green color
	4	UV Spectrophotometry		No absorption	Peak at 244nm
	5	Infrared Analysis			

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
320 NN	1	Birefringence	Positive Optic Sign	Negative Optic Sign	Birefringent
	2*	Microscopic Exam	Natural Fiber Possibly wool	Dumb Bell shape cross-section	
	3	Solubility Tests	Seven reagents tried, B only soluble in dimethylformamide		
	4	Refractive Index		B greater than 1.502	
322 NN	1	Macroscopic Exam	A,B, C different colors		
	2	Microscopic Examination	All animal fibers, probably wool	Color & structure of B different than C Synthetic possibly orlon	Synthetic possibly nylon
324 NN	1	Macroscopic Exam	A, B, C similar in color		
	2*	Microscopic Exam	Animal fiber	B & C both synthetic, but different	
	3	Solubility Tests		Insoluble in acetone HCl Soluble in H_2SO_4	Insoluble in acetone HCl Very sol. in H_2SO_4
	4	Melting Point Determination		Greater than 260°C	258°C
325 NN	1	Macroscopic Exam			
	2*	Birefringence	Low order Optic sign (+)	High order	3rd-4th order Optic sign (+)
330 NN	1	Macroscopic Exam	Lightest	slightly darker	darkest
	2*	Microscopic Exam	A, B, C have different shape of fiber		
331 NN	1*	Microscopic Exam (stereo)	Light Yellow, dull	Greenish, bright	Yellow, bright
		100X	Animal fiber	2 kinds of synthetic fibers	Lime synthetic fiber
	2	Birefringence			
337 NN	1	Macroscopic Exam			
	2*	Microscopic Exam			
340 NN	1	Macroscopic Exam	A, B, C, light green fibers		
	2*	Microscopic Exam	Wool	Synthetic (light green)	Synthetic (Medium green)
341 NN	1*	Microscopic Exam	Scales present Bilobed synthetic		Tri-or-more Lobed synthetic
	2	Solubility Tests	Eight reagents attempted, B soluble in HNO_3		
345 NN	1	Macroscopic Exam	A, B, C same		
	2	Microscopic Exam	Animal fiber	B and C same	
	3	Birefringence	A, B, C all different		
347 NN	1	Macroscopic Exam	A, B, C similar in color - C has more static electricity		
	2*	Microscopic Exam	Wool	Twolobes	Three lobes Possibly polyester
	3	Solubility Tests		B and C different	
	4	Fluorescent Studies	Yellow fluorescence	Yellow Fluorescence	No R_x

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
351	1	Macroscopic Exam			
NN	2*	Microscopic Exam	A, B, C different in size, color, texture		
	3*	Solubility	Insoluble in HCl	Slowly dissolves, yellow solution	Rapidly dissolves, Blue solution
353	1	Pyrolysis G-C	A, B, C dissimilar		
NN	2	Microscopic Exam	Wool	B and C different diameter	
	3	Diameter of fibers		.037 mm	.067 mm
	4	Birefringence			
	5	Refractive Index			
	6	Solubility Tests	Concluded: Item A was wool, Item B was acrylic, Item C was polyester		
356	1*	Microscopic Exam	Hair	Synthetic	Synthetic
NN	2*	Birefringence		B weakly birefringent C moderately birefringent	
359	1	Microscopic Exam	Scales	Very weak medullary	Moderate Synthetic
NN	2	Solubility Tests	H_2SO_4, slow	H_2SO_4, brown & decompose	H_2SO_4, blue and decompose
370	1	Macroscopic Exam			
NN	2*	Microscopic Exam	Wool	Possible nylon	Possible polyester
	3	Solubility Tests		Soluble in H_2SO_4 probably nylon	Soluble in cresol, indicates polyester
371	1	Macroscopic Exam	Color not as bright as B&C	Bright yellow	Bright yellow
NN	2*	Microscopic Exam	round-scaly	flat-ribbon like	round (brighter color than A)
	3	Birefringence	yellow, orange, blue	pale yellow	bright yellow
	4	Fluorescend Studies	A, B, C show no fluorescence		
	5	Solubility Tests	Insol. HCl, H_2SO_4 Acetone, $CHCl_3$ Sol. HKO_3	Ins. HCl, HNO_3 Sol. H_2SO_4, $CHCl_3$	Ins. HCl, Acetone, $ChCl_3$ Sol. H_2SO_4, HNO_3
376	1	Microscopic Exam	Animal fiber	Bi-lobal synthetic	Tri-lobal synthetic
NN	2	Birefringence			
379	1*	Macroscopic Exam			
NN	2	Microscopic Exam			
380	1	Microscopic Exam	Animal	Two-lobed cross section	Multi-lobed cross section
NN	2*	Birefringence		Synthetic	Synthetic
	3	Refractive Index		1st Order n_ω, n_ε approx. 1.51	4th Order n_ε greater than 1.70
384	1	Macroscopic Exam	Green, round, scales	green, flat no scales	dark green, round
NN	2*	Microscopic Exam	Animal hair	Occlusions on fiber striated	Fiber, darker than B, striated
	3	Birefringence		Little or none	High
	4	Solubility Tests		Sol. HNO_3 and N,N-Dimethyl-formamide	Insol. HNO_3 and N,N-Dimethylformamide
	5	Refractive Index		n_ε between 1.51 and 1.53 probably acrylic	n_ε greater than 1.66 probably polyester

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
385	1	Macroscopic Exam			
NN	2*	Microscopic Exam	Wool	2 types of acrylic	
	3	Melting Point Determination			
	4	Solubility Tests	Eight reagents used, B and C different in Dimethylformamide		
	5*	Refractive Index		B and C different	
	6	Birefringence		B and C different	
	7	Infrared Analysis		Polyacrilonitrile	
387	1	Macroscopic Exam	green	yellow-green	yellow-green
NN	2*	Microscopic Exam	animal fiber	synthetic,bi-lobated; 60 micron width	trilobate 30 micron width
	3*	Birefringence	medium low	low	high
388	1	Macroscopic Exam			
NN	2*	Microscopic Exam	animal	synthetic	plant
	3	Birefringence			
	4	Solubility Tests	Five solvents used		
394	1	Microscopic Exam	similar to C but has larger diameter	flat ribbon-like appearance	
NN					
	2*	Infrared Analysis	nylon	natural fiber	polyester
	3	Pyrolysis G-C	Confirmed that neither A nor B had a common origin with C; confirmed polyester		
397	1	Macroscopic Exam			
NN					
	2	Fluorescent Studies			
	3	Microscopic Exam	scales	med. green 2 x 4 units	dark green 4 x 8 units
398	1	Macroscopic Exam			
NN	2*	Microscopic Exam	wool	at least three synthetic fibers, diff. from C	trilobal, synthetic
405	1	Infrared Analysis	A, B, C different		
NN	2*	Microscopic Analysis	Round, scales	Flat, ribbon-like	different than A or B
	3	Melting Point Determination		shrinkage 153-155°C	251-252°C
	4	Refractive Index	$n_{\parallel}$ about 1.56 wool	$n_{\parallel}$ about 1.532 $n_{\perp}$ about 1.532 acrylic fiber	$n_{\parallel}$ about 1.705 $n_{\perp}$ about 1.552 polyester
406	1	Macroscopic Exam	green	green	darker green
NN	2*	Microscopic Exam	Cuticle scales	Dog-bone shaped	Trilobal
	3	Birefringence	Yes	No	Yes
	4	Melting Point Determination		Indeterminate	250-252°C
	5	Solubility Tests		Sol. Dimethyl-formamide	Insoluble in HCl
	6	Pyrolysis G-C	Animal Fiber	Acrylic fiber	Polyester fiber

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
408	1	Macroscopic Exam			
NN	2*	Microscopic Exam	Animal origin	not animal	not animal
	3	Solubility Tests		Sol. in	Insol. in
418	1*	Microscopic Exam	wool	2 types, polyester unk. synthetic	Unknown synthetic diff. from A in diameter
NN	2	Solubility Tests	Insol. H_2SO_4	Sol. H_2SO_4	Sol. H_2SO_4 w/color change
422	1	Macroscopic Exam	A, B, C, similar		
NN	2*	Microscopic Exam	Animal hair	Dumb Bell cross section	Synthetic, not dumb bell shaped
	3*	Infrared Analysis		B and C different	
426	1	Macroscopic Exam	A, B, C yellowish green		
NN	2*	Microscopic Exam	A, B, C, have significant gross differences		
428	1	Visual	A, B, C have subtle differences in color and form		
NN	2	Microscopic Exam	natural fiber	trilobal	trilobal
	3*	Birefringence	Low	Low	High
429	1	Macroscopic Exam			
NN	2*	Microscopic Exam	wool	2 synthetic fibers modacrylic, acrylic	1 synthetic fiber polyester
	3	Solubility Test			
430	1	Macroscopic Exam	light-green-yellow dissimilar to B&C	B and C Lt. Green Yellow, similar	
NN	2*	Microscopic Exam	A, B, C dissimilar		
	3	Melting Point Determination	Charred	Charred	Melted
431	1*	Microscopic Exam	scales	B and C contain differences in diameter and polarized colorations	
NN			wool	acrylic possibly orlon	nylon possibly nomex
	2*	Birefringence	low-medium	low (-) sign of elongation	high
	3	Solubility Tests		Band C insol. in formic acid, m-cresol	
432	1	Macroscopic Exam	A, B, C, yellow		
NN	2*	Microscopic Exam	Round cross-section	Triangular cross-section	Triangular cross-section
	3	Fluorescent Studies	A, B, C, have no fluorescence		
	4*	Infrared Analysis		B different from C	
433	1	Macroscopic Exam			C different from A and B
NN	2	Fluorescent Studies	A, B, C, similar		
	3	Infrared Analysis	A and C similar	B different	
	4*	Solubility Tests	A & B insol.	H_2SO_4	Sol. H_2SO_4
436	1*	Microscopic Exam	Light yellow	Orange	Orange
	2	Melting Point Determination	mix mp-none mp-none	mix mp-117 mp-none	mix mp-110 mp-258
	3*	Cross Section	Round	Dog-bone	Tri-lobal

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
437	1	Macroscopic Exam			
NN	2	Microscopic Exam	wool	blend of synthetic fibers	synthetic
	3*	Solubility Tests	Sol. H_2SO_4, HNO_3	Sol. HNO_3, H_2SO_4	Sol. H_2SO_4 but changed colors in HNO_3
438	1	Macroscopic Exam			
NN	2*	Microscopic Exam			
	3	Solubility Tests	A and B different from C (4 reagents used)		
443	1*	Microscopic Exam	wool	2 synthetic fibers	1 synthetic fiber different from A or B
NN					
444	1	Macroscopic	A slight difference in color from B and C		
NN	2*	Microscopic Exam	wool	striated fibers dog-bone cross-section	striated fibers trilobal cross-section
	3	Birefringence	+ .01	+ .002 - .002	+ .14
	4	Refractive Index		N= 1.53 & 1.52	N= 1.69 N= 1.55
	5	Melting Point Determination	none	none	250
	6	Solubility Tests		acrylic/modacrylic (acrylic likely orlon modacrylic likely verel)	polyester (likely dacron type 62)
445	1*	Microscopic Exam	Animal fiber (wool)	synthetic flat shape	synthetic bright irregular shape
NN	2	Solubility Tests		Sol. HNO_3	Insol. HNO_3
	3	Refractive Index		acrylic	$n_{//}$ = 1.700 polyester
446	1	Macroscopic Exam	green	green	darker green
NN	2*	Microscopic Exam	wool	synthetic	synthetic (different
	3	Solubility Tests	Insoluble in everything used (4 reagents)	Sol. H_2SO_4 HNO_3	Sol. H_2SO_4 from B)
	4	Refractive Index	1.560	1.510	1.718 - $n_{//}$ 1.534 - $n_{\perp}$
449	1	Macroscopic Exam	A, B, C different color of green, A dull, B & C shiny		
NN	2*	Microscopic Exam	hair	B different than C in color and appearance of fibers	
	3	Birefringence		C much more birefringent than B	
450	1	Macroscopic Exam	A, B, C, approximately same color. B and C more lustrous than A		
NN	2*	Microscopic Exam	scale structure	two fibers observed synthetic	one type of synthetic
	3	Refractive Index	$n_{//}$ 1.557, $n_{\perp}$ 1.547	both fibers between 1.51 & 1.54	$n_{//}$ near 1.7
	4	Birefringence	Moderate	Low	Very high
	5	Solubility Tests	Wool	one acrylic & one unidentified fiber 8 reagents tested	Sol. m-cresol polyester

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
452	1	Macroscopic Exam	A, B, C light green, curly		
NN	2*	Microscopic Exam	wool	synthetic, bicomponent low-order color	synthetic, trilobal, high-order color
453	1	Macroscopic Exam			
NN	2*	Microscopic Exam	scales wool	tri-lobed 2 types delustered	tri-lobed not lustered
	3	Refractive Index		$n_{\parallel}$ and $n_{\perp}$ below 1.6	$n_{\parallel}$ higher 1.6 $n_{\perp}$ lower 1.6
	4	Birefringence		negative elongation	positive elongation
455	1	Microscopic Exam	Animal Hair	synthetic fiber	tri-lobal
NN			possibly wool	not tri-lobal	
	2*	Birefringence		negative acrylic	positive
	3	Refractive Index		$n_{\parallel}$ and $n_{\perp}$ both approx. 1.54	$n_{\parallel}$ approx. 1.71 $n_{\perp}$ approx. 1.55
	4	Solubility Tests		Sol. H_2SO_4 Insol. HCL	polyester Insol. HCL, H_2SO_4
462	1	Macroscopic Exam	dull green	B and C lime green	
NN	2*	Microscopic Exam	wool	synthetic, dog-bone cross-section	synthetic, collapsed tubular cross-section
	3	Melting Point Determination		Indeterminate	250°C
	4	Solubility Tests		Sol. HNO_3 acrylic	Sol. dimethylformamide polyester
465	1	Macroscopic Exam	A and B yellow green		dark yellow green
NN	2	Fluorescent Studies	A, B, C no fluorescense		
	3	Solubility Tests	A and B do not dissolve in H_2SO_4		Dissolves in H_2SO_4
	4*	Microscopic Exam	animal (wool)	synthetic	vegetable
468	1	Macroscopic Exam	A different from B and C		
NN	2*	Microscopic Exam	A, B, C all different		
470	1	Microscopic Exam	natural fiber-scales	synthetic fiber granulated	synthetic fiber no granules
NN	2*	Macroscopic Exam		dog-bone cross-section	trilobular cross-section
472	1	Macroscopic Exam	dull	glossy	glossy
NN	2*	Microscopic Exam	wool	orlon type acrylic	dacron type 62 type polyester
	3	Solubility Tests			no effect in 1:1 HCL

* indicates the point where a conclusion was reached

Table 8 (continued)

Lab Code	Sequence of Testing	Test	Item A	Item B	Item C
473 NN	1	Microscopic Examination			
474 NN	1*	Macroscopic Exam	A, B, C, greenish fibers		large amount of static electricity in C
	2	Fluorescent Studies	yellow fluorescence	yellow-orange fluorescence	no fluorescence
	3	Microscopic Exam	scales present wool	possibly nylon 6-6 Dupont Type 501	possibly darvan or arvel
	4	Solubility Tests	confirmed as wool	confirmed as nylon 6-6 Dupont type 501	confirmed as arvel
476 NN	1	Macroscopic Exam			
	2*	Microscopic Exam			
478 NN	1	Microscopic Exam	Animal hair fibers (wool)	extruded textile	synthetic fibers
	2*	Fluorescent Studies		fluorescence	no fluorescence
479 NN	1	Microscopic Exam	A and B light green A has scales animal hair		bright green
	2	Solubility Tests		5 reagents used; B is soluble only in HNO_3	C insoluble in all reagents
	3	Birefringence	(+) 0.01	(-) 0.006	Indeterminate
	4*	Pyrolysis G-C		B and C different	
482 NN	1	Macroscopic Exam	Failure to differentiate between A, B and C		
	2*	Microscopic Exam	Structural differences noted in A, B and C		
	3	Birefringence	A, B, C different		
	4	Melting Point Determination	A, B, C different		
493 NN	1	Macroscopic Exam	A straighter fibers than B or C		C showed greater sheen than A or B
	2*	Microscopic Exam	wool	B different than C	
499 NN	1	Macroscopic Exam	green	B and C green, different than A	
	2*	Microscopic Exam	wool	synthetic B and C are different	synthetic
	3	Birefringence	A, B, C different		

* indicates the point where a conclusion was reached

END