



Glass Analysis

Test No. 24-5481 Summary Report

Each sample set contained a known glass sampling and two sets of questioned glass fragments. Participants were asked to examine the questioned fragments using their existing protocols. Data were returned from 67 participants and compiled into the following tables:

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This report contains the data received from the participants in this test. Since these participants are located in many countries around the world, and it is their option how the samples are to be used (e.g., training exercise, known or blind proficiency testing, research and development of new techniques, etc.), the results compiled in the Summary Report are not intended to be an overview of the quality of work performed in the profession and cannot be interpreted as such. The Summary Comments are included for the benefit of participants to assist with maintaining or enhancing the quality of their results. These comments are not intended to reflect the general state of the art within the profession.

Participant results are reported using a randomly assigned "WebCode". This code maintains participant's anonymity, provides linking of the various report sections, and will change with every report.

Manufacturer's Information

Each sample set contained a known glass sampling and two sets of questioned glass fragments. Participants were asked to examine the questioned fragments and determine if either could have originated from the same source as the recovered known glass sampling.

SAMPLE PREPARATION: The glass was examined for defects and then broken, utilizing glass tools to remove edges and unwanted areas. Elimination items were processed and packaged separately from other items to prevent cross-contamination. Association items were selected at the same time and within close spatial proximity to one another prior to item packaging and maintained together as association batches during sample set assembly.

KNOWN ITEMS: Two glass fragments, approximately 1/8" x 1/8" in size, were selected and deposited into a glassine bag and then placed into a pre-labeled item envelope and sealed.

QUESTIONED ITEMS: Two glass fragments, approximately 1/16" x 1/16" in size, were selected and deposited into a glassine bag and then placed into a pre-labeled item envelope and sealed.

SAMPLE SET ASSEMBLY: All items were placed into a pre-labeled sample set envelope and sealed. This process was repeated until all of the sample sets were prepared.

VERIFICATION: Predistribution results were consistent with each other and the manufacturer's preparation information. The following procedures were used to examine the items: Color, Density, Thickness, nD Refractive Index, Long and Short UV Fluorescence, ALS Fluorescence, and XRS/XRF. The average refractive indices for the glass as reported by predistribution laboratories are as follows: Item 1 RI = 1.51887, Item 2 RI = 1.51656, and Item 3 RI = 1.51887.

Item	Known/ Questioned	Association/ Elimination	Manufacturer	Glass Type
1	Known	Association	ABC Glass & Mirror	Single Pane
2	Questioned	Elimination	Project Source	Window
3	Questioned	Association	ABC Glass & Mirror	Single Pane

Summary Comments

This test was designed to allow participants to assess their proficiency in the examination, comparison, and interpretation of glass samples. Participants were supplied with one known glass sampling (Item 1) and two sets of questioned glass fragments (Items 2 and 3). Items 1 and 3 were prepared from the same source of glass. Item 2 was prepared from a different source of glass. Refer to the Manufacturer's Information for preparation details.

Of the 67 responding participants, 66 (99%) identified Item 3 and eliminated Item 2 as having originated from the same source as the Item 1 known glass. The remaining participant eliminated both Items 2 and 3 as having originated from the same source as the Item 1 known glass.

The most commonly reported examination procedures include: Thickness, Color, nD Refractive Index, and Short UV Fluorescence.

Examination Results

Could the questioned glass fragments recovered from the suspect (Item 2 and Item 3) have originated from the broken bedroom window as represented by Item 1?

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
2LD7AC	No	Yes	EXPR2Z	No	Yes
3F9NEW	No	Yes	FC76XR	No	Yes
3WQP8E	No	Yes	FQKA6K	No	Yes
4NFNLD	No	Yes	G9ZYWQ	No	Yes
6VB6DU	No	Yes	GDUZVK	No	Yes
7FEAE9	No	Yes	GL63GK	No	Yes
7WL8ZT	No	Yes	H2DDKX	No	Yes
9HUJHQ	No	Yes	HJDM4V	No	Yes
9NH4L7	No	Yes	JBX4JV	No	Yes
A2UH3D	No	Yes	JEXEFV	No	Yes
A3H6Y8	No	Yes	K4TMNF	No	Yes
A8CYXU	No	Yes	KJ7VPJ	No	Yes
B9G7ER	No	Yes	M2GLKK	No	Yes
BDDQKW	No	Yes	MUG8UD	No	Yes
BLNT7X	No	Yes	NMWQF9	No	Yes
BREAHN	No	Yes	NRA9WP	No	Yes
BYDRWZ	No	Yes	NRPU7R	No	Yes
CFC9F4	No	Yes	NW2EWL	No	Yes
CY823M	No	Yes	PZYJKP	No	Yes
D2T7BK	No	Yes	Q8CQ3E	No	Yes
DUBWMN	No	Yes	R3C3GP	No	Yes
DUVD3Q	No	Yes	RE4PMK	No	Yes
E8CN9T	No	Yes	RPPTW6	No	Yes
EEVYF3	No	Yes	RQT3LX	No	Yes
EQRXAT	No	Yes	RRUGEF	No	Yes

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
TCXJM6	No	Yes			
TK9L97	No	Yes			
UA8KA7	No	Yes			
UWL678	No	Yes			
UZHWCJ	No	Yes			
V9BNXH	No	Yes			
W4W7FZ	No	No			
W8WGCZ	No	Yes			
WPCQC2	No	Yes			
WYQNFR	No	Yes			
X3G9N2	No	Yes			
XBQX2Z	No	Yes			
XNWLHA	No	Yes			
Y466ME	No	Yes			
YCET2D	No	Yes			
ZEYZZZ	No	Yes			
ZRA7FA	No	Yes			

Response Summary		Total Participants: 67	
<i>Could the questioned glass fragments recovered from the suspect (Item 2 and Item 3) have originated from the broken bedroom window as represented by Item 1?</i>			
		<u>Item 2</u>	<u>Item 3</u>
Yes:	0 (0.0%)	66 (98.5%)	
No:	67 (100.0%)	1 (1.5%)	
Inconclusive:	0 (0.0%)	0 (0.0%)	

Examination Procedures

TABLE 2

WebCode	Refractive Index				Color	Density	Thickness	Elemental		UV		
	nD	nF	nC	Δ RI				SEM/ EDS	XRS/ XRF	Long	Short	Other
2LD7AC	✓				✓		✓		✓	✓	✓	PLM
3F9NEW					✓		✓	✓				
3WQP8E	✓				✓		✓		✓	✓	✓	Stereomicroscopy, high power and polarized light microscopy
4NFNLD	✓				✓		✓		✓		✓	
6VB6DU								✓				FTIR
7FEAE9							✓	✓				
7WL8ZT	✓			✓	✓		✓		✓			LA-ICP-MS
9HUJHQ				✓		✓	✓		✓			
9NH4L7	✓				✓	✓	✓					ALS fluorescence: <530nm; 525nm; 485nm; 450nm; 570nm
A2UH3D					✓		✓	✓	✓	✓		
A3H6Y8	✓				✓		✓		✓	✓	✓	
A8CYXU	✓			✓	✓		✓	✓			✓	
B9G7ER	✓				✓		✓				✓	LA-ICP-MS
BDDQKW	✓				✓		✓	✓			✓	
BLNT7X	✓				✓		✓			✓	✓	
BREAHN				✓	✓		✓	✓	✓	✓	✓	
BYDRWZ	✓				✓		✓		✓	✓	✓	
CFC9F4	✓				✓		✓			✓	✓	
CY823M	✓				✓		✓	✓		✓	✓	
D2T7BK	✓						✓	✓		✓	✓	PLM
DUBWMN				✓	✓		✓					
DUVD3Q	✓				✓		✓				✓	LA-ICP-MS
E8CN9T	✓				✓		✓		✓	✓	✓	

TABLE 2

WebCode	Refractive Index				Color	Density	Thickness	Elemental		UV		
	nD	nF	nC	Δ RI				SEM/ EDS	XRS/ XRF	Long	Short	Other
EEVYF3	✓				✓		✓			✓	✓	LA-ICP-MS
EQRXAT	✓				✓		✓	✓		✓	✓	
EXPR2Z					✓		✓	✓		✓	✓	
FC76XR	✓				✓		✓	✓		✓	✓	
FQKA6K						✓						LIBS, μ XRF
G9ZYWQ	✓				✓		✓	✓			✓	
GDUZVK	✓			✓	✓		✓	✓			✓	
GL63GK	✓						✓	✓				
H2DDKX	✓				✓		✓	✓		✓	✓	
HJDM4V	✓	✓	✓		✓		✓	✓				
JBX4JV	✓				✓		✓	✓		✓	✓	
JEXEFV	✓				✓		✓	✓			✓	
K4TMNF					✓		✓	✓		✓	✓	GRIM
KJ7VPJ	✓					✓	✓	✓			✓	
M2GLKK	✓				✓		✓	✓		✓	✓	
MUG8UD	✓	✓			✓		✓	✓			✓	
NMWQF9	✓											
NRA9WP				✓	✓		✓					
NRPU7R				✓			✓	✓			✓	
NW2EWL	✓				✓		✓	✓		✓	✓	Macroscopic and microscopic examinations of glass type/morphology
PZYJKP	✓				✓		✓			✓	✓	
Q8CQ3E	✓				✓		✓	✓				
R3C3GP	✓				✓		✓	✓			✓	
RE4PMK	✓				✓		✓			✓	✓	
RPPTW6												ICP-MS

TABLE 2

WebCode	Refractive Index				Color	Density	Thickness	Elemental		UV		
	nD	nF	nC	ΔRI				SEM/EDS	XRS/XRF	Long	Short	Other
RQT3LX	✓				✓		✓		✓		✓	
RRUGEF	✓				✓		✓	✓				
TCXJM6	✓				✓		✓		✓			
TK9L97	✓			✓			✓				✓	Surface features
UA8KA7	✓				✓		✓		✓	✓	✓	
UWL678				✓	✓		✓					ICP-MS
UZHWCJ	✓				✓		✓		✓	✓	✓	
V9BNXH					✓		✓				✓	LA-ICP-MS
W4W7FZ					✓		✓	✓		✓		
W8WGCZ	✓				✓		✓		✓	✓	✓	
WPCQC2							✓		✓			LA-ICP/MS
WYQNFR	✓				✓		✓	✓	✓			
X3G9N2	✓				✓		✓			✓	✓	LA-ICP-MS
XBQX2Z	✓			✓	✓		✓			✓	✓	
XNWLHA	✓				✓		✓		✓	✓	✓	
Y466ME	✓			✓	✓		✓					surface analysis
YCET2D					✓		✓		✓	✓	✓	
ZEYZZZ							✓					LIBS
ZRA7FA	✓				✓		✓		✓	✓	✓	

Response Summary												
Participants	Refractive Index				Color	Density	Thickness	Elemental		UV		
	nD	nF	nC	ΔRI				SEM/EDS	XRS/XRF	Long	Short	
67	48	2	1	12	54	4	63	18	32	31	44	
Percent	72%	3%	1%	18%	81%	6%	94%	27%	48%	46%	66%	

Conclusions

TABLE 3

WebCode	Conclusions
2LD7AC	<p>The following methodologies were used in the examination of this case: visual examination, physical examination, microscopy, digital calipers, UV fluorescence, XRF and GRIM3. Examination of Item 2 revealed the presence of two broken glass fragments. These fragments were not consistent in physical characteristics and elemental composition with the known standard (Item 1). Therefore, the fragments in Item 2 and Item 1 could not have shared a common origin. Examination of Item 3 revealed the presence of two broken glass fragments. These fragments were consistent in physical characteristics, elemental composition and refractive index with the known standard (Item 1). Therefore, the fragments in Item 3 and Item 1 could have originated from the same source or another source of broken glass with the same physical characteristics, elemental composition and refractive index.</p>
3F9NEW	<p>Item 1 and 3 were considered to have originated from the same source due to having the same thickness between the two flat, opposing, original surfaces and the extremely similar elemental compositions.</p>
3WQP8E	<p>The questioned glass samples, Items 2 and 3, were examined and compared to the known sample, Item 1. Items 1 and 3 are similar in thickness; however Item 2 is different in thickness. Items were further analyzed for elemental composition and optical properties (refractive index). Known Item 1 and questioned Item 3 are consistent with respect to their physical characteristics, elemental composition, and optical properties. Therefore, this glass sample from the suspect, Item 3, either came from the bedroom window, as represented by Item 1, or from another source of broken glass exhibiting all of the same analyzed characteristics. Known Item 1 and questioned Item 2 are different in thickness, elemental composition and optical properties; therefore this glass sample from the suspect, Item 2, did not come from the bedroom window, as represented by the submitted sample Item 1.</p>
4NFNLD	<p>Examinations: Visual examination, thickness measurements, ultraviolet radiation, X-ray fluorescence, refractive index measurements Information: Questioned glass fragments reportedly recovered from a person (Items 2, 3) and known glass reportedly collected from a bedroom window (Item 1) were examined and compared. Results: The questioned glass within Item 2 differed from the known glass in elemental composition. In the opinion of the examiner, the bedroom window as represented by Item 1 was excluded as a potential source of the glass within Item 2. (Elimination) The questioned glass within Item 3 corresponded with the known glass in color (clear), thickness, type (float), elemental composition, and refractive index. In the opinion of the examiner, the questioned glass from Item 3 originated either from the bedroom window as represented by Item 1 or from another broken window with indistinguishable properties. Because similar glass has been manufactured that would be indistinguishable from the submitted evidence, an individual source cannot be determined. (Level 3 - Association)</p>
6VB6DU	<p>Based on the SEM/EDS analysis, it is concluded that item 3 cannot be excluded as having originated from item 1. Conversely, Item 2 could not have originated from item 1 based on containing consistently higher proportions of K and Al and lower Ca on both sides and higher Sn on one side, when compared to item 1. These results are consistent with those from the FTIR analysis.</p>
7FEAE9	<p>Based on applied methods, the evidence (elemental composition of glass samples as well as the thickness measurements) provides support for the proposition that questioned glass fragments recovered from the suspect described as Item 3 could have originated from the broken bedroom window (Item 1) while questioned glass fragments recovered from the suspect described as Item 2 could not have originated from the broken bedroom window (Item 1).</p>

TABLE 3

WebCode	Conclusions
7WL8ZT	The fragments of Item 3 – based on type, colour, thickness, elemental composition measured by micro-XRF and LA-ICP-MS, and based on the RI values measured before and after annealing, also – can most likely originate from the glass represented by known sample Item 1. The fragments of Item 2 – based on elemental composition measured by micro-XRF and LA-ICP-MS, and based on the RI values measured before and after annealing, also – cannot originate from the glass represented by known sample Item 1.
9HUJHQ	The questioned glass fragments recovered from suspect (item 3) could be originated from the glass fragments recovered from the broken bedroom window. (item 1). The questioned glass fragments recovered from suspect (item 2) could not have been originated from the glass fragments recovered from the broken bedroom window. (item 1).
9NH4L7	RESULTS: Items #1-1, #1-2, and #1-3 were examined for color, average thickness, density properties, and refractive index using the glass refractive index measurement system (GRIM). The analyzed glass pieces in item #1-2 did not correspond in thickness or refractive index with the known glass sample, item #1-1. The analyzed glass pieces in item #1-3 corresponded in color, thickness, density, and refractive index with the known glass sample, item #1-1. OPINION: The glass pieces in item #1-2 could not have originated from the same source as the known glass sample, item #1-1. This is an Elimination. See Association Key below. The glass pieces in item #1-3 could have originated from the broken glass represented by the known, item #1-1, or another source of broken glass with the same properties. This is a Type III Association. See Association Key below. [Association Key was not included with the report].
A2UH3D	It has been determined that the glass samples numbered 1 are physically and chemically SIMILAR to the glass samples numbered 3. It has been determined that the glass samples numbered 1 are physically and chemically DIFFERENT from the glass samples numbered 2.
A3H6Y8	Based on our examination (RI and elemental analysis) the questioned glass particles recovered from the suspect (Item 3) could not been differentiated from the material of comparison of the broken bedroom window (Item 1). They could therefore have a common source. The questioned glass particles recovered from the suspect (Item 2) could be clearly distinguished from the material of comparison of the broken bedroom window (Item 1) and could be excluded as being the origin of those questioned particles.
A8CYXU	The results give extremely strong support for the hypothesis that the examined pieces of glass in Item 2, from the suspect, do not originate from the broken window represented by Item 1 (Level -4). The results give support for the hypothesis that the examined pieces of glass in Item 3, from the suspect, originate from the broken window represented by Item 1 (Level +2).
B9G7ER	Glass recovered from the suspect (Item 3) is indistinguishable from glass from the bedroom window (Item 1). Consequently, the glass from the suspect (Item 3) either originated from the bedroom window (Item 1) or from another source of broken glass indistinguishable in all of the measured or observed physical properties, refractive index, and elemental composition. Glass recovered from the suspect (Item 2) is different from the glass from the bedroom window (Item 1). Consequently, the glass from the suspect (Item 2) did not originate from the same source as the glass from the bedroom window (Item 1).
BDDQKW	Both the known glass (Item 1) and recovered glass in Item 3 consisted of two small pieces of colourless, toughened, flat, float glass, of thickness 2.9 millimetres. In addition, the known glass (Item 1) and recovered glass (Item 3) were indistinguishable, with respect to their refractive indices and elemental compositions. Therefore, the glass in Item 3 could have originated from the same source as the known glass (Item 1). The recovered glass in Item 2 consisted of two small pieces of toughened, flat, float glass, with a thickness of 3.1 millimetres. These glass pieces were distinguishable to the known glass (Item 1) with respect to

TABLE 3

WebCode	Conclusions
	their thickness and refractive index. Therefore, the recovered glass in Item 2 could not have originated from the same source as the known glass (Item 1).
BLNT7X	I formed the opinion based on the techniques used, that the glass fragments recovered from the suspect (item 3) had the same appearance and refractive index as the control glass collected from the broken bedroom window (item 1) and could have originated from it. I also formed the opinion based on the techniques used, that the glass fragments recovered from the suspect (item 2) had a different thickness and refractive index as the control glass collected from the broken bedroom window (item 1) and could not have originated from it.
BREAHN	On analysis, I found: i) The refractive index of the questioned glass fragments recovered from the suspect (Item 3) to be similar to the refractive index of the known glass fragments recovered from the broken bedroom window (Item 1). ii) The refractive index of the questioned glass fragments recovered from the suspect (Item 2) to be dissimilar to the refractive index of the known glass fragments recovered from the broken bedroom window (Item 1). Therefore, I am of the opinion that: i) The questioned glass fragments recovered from the suspect (Item 3) could have originated from the known glass fragments recovered from the broken bedroom window (Item 1). ii) The questioned glass fragments recovered from the suspect (Item 2) did not originate from the known glass fragments recovered from the broken bedroom window (Item 1).
BYDRWZ	The glass sample from suspect (Item 2) did not originate from the glass standard recovered from the broken bedroom window (Item 1) (Elimination). The glass sample from suspect (Item 3) is associated to the glass standard recovered from the broken bedroom window (Item 1) upon comparison of optical, physical, and elemental properties. These fragments either originated from this item or from another item with same characteristics (Level III Association).
CFC9F4	The glass from Item-2 (Questioned glass fragments recovered from the suspect) and the Item-1 (Known glass fragments recovered from the broken bedroom window) were inconsistent and could not have originated from the same source. The glass from Item-3 (Questioned glass fragments recovered from the suspect) and the Item-1 (Known glass fragments recovered from the broken bedroom window) were consistent and could have originated from the same source.
CY823M	The glass fragments recovered from the suspect (Item #3) compare by physical, elemental, and optical properties to the glass fragments recovered from the scene (Item #1), indicating that they could have come from the same piece of glass or another glass source with indistinguishable properties. The glass fragments recovered from the suspect (Item #2) do not compare to the glass fragments recovered from the scene (Item #1).
D2T7BK	Examination and comparison of Items 1 and 3 revealed glass that were found to be similar in all measured physical, microscopic, optical properties and elemental composition. They could have come from the same source or any other source with the same properties. Examination and comparison of Items 1 and 2 revealed glass that were found to be dissimilar in all measured physical and optical properties. They could not have come from the same source.
DUBWMN	According to the results of the glass refractive index measurements, we found that: a) The questioned glass fragments recovered from the suspect Item 2 does not match the fragments of the broken bedroom window (Item 1). b) The questioned glass fragments recovered from the suspect Item 3 match the fragments of the broken bedroom window (Item 1). The questioned glass fragments recovered from the suspect Item 3 could have originated from the known sample Item 1 recovered from the bedroom window.
DUVD3Q	Glass recovered from the debris from the suspect as represented by Item 3 is indistinguishable from the glass recovered from the broken bedroom window (Item 1). Accordingly, the Item 3

TABLE 3

WebCode	Conclusions
	<p>glass fragments either originated from the broken bathroom window as represented by Item 1 or from another source of broken glass indistinguishable in all of assessed physical characteristics, refractive index, and elemental composition. See "Inclusion with Elemental Composition Examination" in the Interpretation Section, below. Glass recovered from the debris from the suspect as represented by Item 2 is different from the glass recovered from the broken bedroom window (Item 1). Accordingly, the Item 2 glass fragments are eliminated as originating from the broken bathroom window as represented by Item 1. See "Exclusion" in the Interpretations section below.</p>
E8CN9T	<p>CONCLUSIONS: Two glass fragments identified as recovered from the suspect (Item 3) either originated from the bedroom window (Item 1) or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics. Two glass fragments identified as recovered from the suspect (Item 2) did not originate from the bedroom window (Item 1). RESULTS: Questioned glass fragments identified as recovered from the suspect (Items 2 and 3) were examined for the purpose of determining whether or not they are like the known glass standard from the broken bedroom window (Item 1). The known glass standard from the bedroom window (Item 1) is colorless non-tempered float sheet glass. Examination of Item 3 revealed two full thickness glass fragments. Examination and comparison of these questioned glass fragments recovered from the suspect (Item 3) with the known glass standard from the bedroom window (Item 1) reveals they are alike with respect to physical, optical, and chemical characteristics. It is therefore concluded that these questioned glass fragments recovered from the suspect (Item 3) either originated from the bedroom window (Item 1) or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics. Examination of Item 2 revealed two full thickness glass fragments. Examination and comparison of these questioned glass fragments recovered from the suspect (Item 2) with the known glass standard from the bedroom window (Item 1) reveals they are dissimilar with respect to chemical characteristics. It is therefore concluded that these questioned glass fragments recovered from the suspect (Item 3) did not originate from the bedroom window (Item 1). METHODS OF ANALYSIS: Examinations were performed visually, by stereo microscopy, polarized light microscopy, ultraviolet fluorescence, micrometry, refractive index determination, and x-ray fluorescence spectroscopy.</p>
EEVYF3	<p>The questioned glass fragments marked "Item 2", recovered from the suspect, were found to be different from the known glass fragments marked "Item 1", recovered from the broken bedroom window, in terms of trace elemental composition and refractive index. Hence, the questioned glass fragments marked "Item 2" did not originate from the same source as the known glass fragments marked "Item 1". The questioned glass fragments marked "Item 3", recovered from the suspect, were found to have no exclusionary difference with the known glass fragments marked "Item 1", recovered from the broken bedroom window, in terms of colour, fluorescence, thickness, refractive index and trace elemental composition. Hence, the questioned glass fragments marked "Item 3" were very likely to have originated from the same source as the known glass fragments marked "Item 1"; other sources of glass with similar characteristics are limited.</p>
EQRXAT	<p>The questioned glass in Item 3 was indistinguishable from the known glass in Item 1 in optical, physical, and elemental properties (Type 3 Association). This means the questioned glass fragments recovered from the suspect (Item 3) could have come from the broken bedroom window. The questioned glass in Item 2 was different from the known glass in Item 1 (Elimination). This means that the questioned glass fragments recovered from the suspect (Item 2) did not come from the broken bedroom window. TRACE INTERPRETATION SCALE: Type 1 Association: Physical Fit—The compared items exhibit physical features that demonstrate they were once part of the same object. Type 2 Association: Association with Distinctive</p>

TABLE 3

WebCode	Conclusions
	<p>characteristics—Items are consistent in all measured and observed physical properties, chemical composition and/or microscopic characteristics, and therefore could have originated from the same source. The items further share distinctive characteristics that would not be typically encountered in the relevant population. Type 3 Association: Association with Conventional characteristics—Items are consistent in all measured and observed physical properties, chemical composition and/or microscopic characteristics, and therefore could have originated from the same source. Because other items have been manufactured or are naturally occurring that would also be indistinguishable from the submitted evidence, an individual source cannot be determined. Type 4 Association: Association with limited characteristics and/or examination. (1) Items are consistent in all measured and observed physical properties, chemical composition and/or microscopic characteristics, and therefore could have originated from the same source. This type of evidence may be commonly encountered in the environment or may have limited comparative value. Or (2) The comparison between items may be categorized as a Type 4 Association if the association is limited by the inability to perform a complete analysis or if minor variations are observed in the examination results. Inconclusive—No conclusion could be reached regarding an association or an elimination between the items. Elimination—Items exhibit differences in one or more of the following: physical properties, chemical composition, or microscopic characteristics and therefore did not originate from the same source. Non-Association—The items were different in physical properties, chemical composition, and/or microscopic characteristics, indicating that the items did not originate from the same source. However, these differences were insufficient for a definitive elimination.</p>
EXPR2Z	<p>Item 1: Known glass recovered from the broken bedroom window. This item was used for comparison purposes. Item 2: Questioned glass recovered from the suspect. The questioned glass (further labeled Q2A and Q2B) recovered from the suspect was determined to be glass which is dissimilar in thickness to the known glass from the broken bedroom window (Item 1). It is our opinion that this item did not come from the known glass from the broken bedroom window. Item 3: Questioned glass recovered from the suspect. The questioned glass (further labeled Q3A and Q3B) recovered from the suspect was determined to be glass which is similar in visual color, thickness, fluorescence, and elemental composition to the known glass from the broken bedroom window (Item 1). It is our opinion that this item could have come from the known glass from the broken bedroom window or any other source of broken glass with similar characteristics. Please note, refractive index comparison between this item and the known glass from the broken bedroom window cannot be performed by our laboratory at this time.</p>
FC76XR	<p>Exhibit 1 (known glass from the broken bedroom window) disclosed the presence of two full thickness fragments of colorless flat glass. (The two fragments are from a single source so only one fragment was tested). Exhibit 2 (questioned glass) and Exhibit 3 (questioned glass) each disclosed the presence of two full thickness fragments of colorless flat glass. (The two fragments within each exhibit are from a single source so one fragment from each exhibit was tested). Comparative examinations of the glass fragment in Exhibit 1 with the glass fragment in Exhibit 3 disclosed them to be consistent in physical characteristics, refractive indices, and elemental compositions. Therefore, the glass fragment in Exhibit 3 could have originated from the bedroom window as represented by the glass fragment in Exhibit 1, or another source with the same characteristics (Type III Inclusion). This type of association was reached because the techniques utilized in this comparative analysis can typically distinguish most glass products. It should be noted that glass fragments can only originate from broken objects and not intact objects. Comparative examinations of the glass fragment in Exhibit 1 with the glass fragment in Exhibit 2 disclosed them to differ in elemental characteristics. Therefore, the glass fragment in Exhibit 2 did not originate from the bedroom window as represented by the glass fragment</p>

TABLE 3

WebCode	Conclusions
	in Exhibit 1 (Exclusion).
FQKA6K	Item 1 identical Item 3; Item 1 not identical Item 2.
G9ZYWQ	The questioned glass fragments in Item 3 agreed in colour, thickness, UV fluorescence characteristics, elemental composition and refractive index with the known glass fragments in Item 1 whereas the questioned glass fragments in Item 2 did not. Therefore, the questioned glass fragments recovered from the suspect in Item 3 could have originated from the same source as the known glass fragments recovered from the broken bedroom window Item 1. Conversely, the questioned glass fragments recovered from the suspect in Item 2 did not originate from the said window.
GDUZVK	In my opinion, the findings provide strong support for a proposition that the glass of Item 3 originated from the broken window at the scene, rather than it did not. The glass of Item 2 did not originate from the broken window at the scene.
GL63GK	Item2 vs Item1: The questioned glass fragments (Item 2) recovered from the suspect could not have originated from the broken bedroom window as represented by Item 1, because we found differences in the thickness, the refractive index and the elemental compositions of Item 2 and Item 1. Item3 vs Item1: The questioned glass fragments (Item 3) recovered from the suspect could have originated from the broken bedroom window as represented by Item 1, because we did not find differences in the thickness, the refractive index and the elemental compositions of Item 3 and Item 1.
H2DDKX	It was determined utilizing a micrometer and X-Ray Fluorescence Spectroscopy that the questioned glass from item 2 and known glass from item 1 exhibit dissimilar physical and chemical characteristics. Therefore, the known glass from item 1 can be eliminated as being the source of the questioned glass. It was determined utilizing a micrometer, polarized light microscopy, Glass Refractive Index Measurement system (GRIM3) and X-Ray Fluorescence Spectroscopy that the questioned glass from item 3 and known glass from item 1 exhibit consistent physical, optic and chemical characteristics. Therefore, the known glass from item 1 cannot be eliminated as being the source of the questioned glass.
HJDM4V	No class-characteristic association was found upon comparing thickness and RI values (nD only) of Item 2 fragments to those of Item 1 fragments. Therefore, Item 2 fragments do not share a common source with Item 1 fragments. Class-characteristic associations were found upon comparing thickness and RI values (nD, nC, and nF) of Item 3 fragments to those of Item 1 fragments. Therefore, Item 3 fragments either share a common source or originate from another source that is class-characteristic associated to Item 1 fragments.
JBX4JV	Item 1: One (1) piece of clear, colorless glass analyzed for comparison to items 2 and 3. Item 2: One (1) piece of clear, colorless glass was analyzed. The unknown glass "recovered from the suspect" and the standard glass (item 1) "recovered from the broken bedroom window" are not the same in physical characteristics. The unknown glass "recovered from the suspect" could not have originated from the standard. Item 3: One (1) piece of clear, colorless glass was analyzed. The unknown glass "recovered from the suspect" either originated from the standard glass (item 1) "recovered from the broken bedroom window" or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics.
JEXEFV	The glass fragments in item 2 were inconsistent with the glass fragments in item 1 with respect to thickness and refractive index. This indicates that the glass fragments in item 2 do not share a common origin with the glass fragments in item 1. The glass fragments in item 3 were consistent with the glass fragments in item 1 with respect to color, fluorescence, thickness, refractive index and elemental composition. This indicates that the glass fragments in item 3 could share a common origin with the glass fragments in item 1 or any other glass with the

TABLE 3

WebCode	Conclusions
	same physical and chemical characteristics.
K4TMNF	Item 2 could not have originated from Item 1. Item 3 could have originated from Item 1.
KJ7VPJ	Based on the test procedures selected above, we can conclude that "Item 1" is connected/related to "Item 3." We submit that "Item 2" does not show any similarities in properties or characteristics to "Item 1." Refractive Index: (Cargille Certified refractive index liquids): Item 1 - 1.52 to 1.53. Item 2 - 1.54 to 1.56. Item 3 - 1.52 to 1.53. Thickness: (Calibrated Calipers): Item 1 - 0.116 inch. Item 2 - 0.122 inch. Item 3 - 0.116 inch. Density: (Archimedes Principle): Item 1 - 2.4963. Item 2 - 2.3892. Item 3 - 2.4916. XRF (Rigaku CG NEX EDXRF): Heavy Metals (ppm), SiO ₂ , Al ₂ O ₃ , CaO, Na ₂ O, MgO, Fe ₂ O ₃ (%mass) "Item 1" was more closely related to "Item 3" per the listed analytes. Example: Item 1 - SiO ₂ % - 68.50 %mass. Item 2 - SiO ₂ % - 72.02 %mass. Item 3 - SiO ₂ % - 69.69 %mass. UV Fluorescence: Short wave - did not see any differences between the samples End of Conclusion.
M2GLKK	The questioned glass fragments in Exhibits 2 and 3 were compared to the known glass fragments in Exhibit 1. The glass fragments in Exhibit 1 and the glass fragments in Exhibit 3 are clear, colorless glass. Comparison of Exhibits 1 and 3 by visual and microscopical techniques, refractive index and elemental composition determined that they could not be differentiated. Therefore, the questioned glass originated from the same source as Exhibit 1 (submitted as a known sample) or another source of broken glass indistinguishable in the measured properties (Type III Inclusion). This type of association was reached because the techniques utilized in this comparative analysis can typically distinguish most glass products. It should be noted that glass fragments can only originate from broken objects and not intact ones. The glass fragments in Exhibit 2 differ in elemental composition from the glass in Exhibit 1. Therefore the window glass source represented as Exhibit 1 is not the source of Exhibit 2 (Exclusion).
MUG8UD	The questioned glass fragments recovered from the suspect (Item 2) and the known glass fragments recovered from the broken bedroom window (Item 1) did not conform in thickness. The results have a lot to commend the questioned glass fragments recovered from the suspect (Item 2) and the recovered from the broken bedroom window (Item 1) did not originate from the same source. The questioned glass fragments recovered from the suspect (Item 3) and the known glass fragments recovered from the broken bedroom window (Item 1) conformed in all investigated features (thickness, RI (nD and nF), color, short fluorescence, chemical composition). There is evidence that the questioned glass fragments recovered from the suspect (Item 3) and the known glass fragments recovered from the broken bedroom window (Item 1) originate from the same source.
NMWQF9	The fragments recovered from the suspect (Item 3) show the same results in all the analyses performed than the known glass fragments recovered from the broken bathroom window (Item 1). The fragments recovered from the suspect (Item 2) show different results in all the analyses performed than the known glass fragments recovered from the broken bathroom window (Item 1).
NRA9WP	Glass shards in Item 2 are different glass from those in Item 1 regarding glass grade. Glass shards in Item 3 are similar glass to those in Item 1 regarding colour, thickness and glass grade.
NRPU7R	All fragments of all 3 items had both original glass-surfaces. Item 1 and Item 3 showed the same thickness of 2.98mm. Item 2 showed a thickness of 3.12mm. All 3 Items showed a white fluorescence under UV-light at a wavelength of 254nm on one of the surfaces, which is typical for floatglass. All fragments of Item 1 and Item 3 had the same inorganic composition and couldn't be differentiated by their refractive index. The inorganic composition of both

TABLE 3

WebCode	Conclusions
	<p>fragments of Item 2 showed different concentrations of iron and aluminum compared with Item 1 and Item 3 and Item 2 could also be differentiated from Item 1 and Item 3 by the refractive index. It is probable that item 3 (recovered from the suspect) originated from the broken bedroom window from the victims residence (Item 1). It is impossible that Item 2 (recovered from the suspect) originated from the broken bedroom window from the victims residence (Item 1).</p>
NW2EWL	<p>RESULTS: The sample in Item 1 consists of two colorless glass fragments that exhibit characteristics consistent with non-tempered float sheet (window) glass. These fragments have their full thickness and were used as standards for comparison to the glass in Items 2 and 3. Item 2 consists of two colorless glass fragments that have their full thickness and exhibit characteristics consistent with non-tempered float sheet (window) glass. Exclusionary differences between Item 2 and the Item 1 known standard were observed with respect to their chemical compositions. It is therefore concluded that the Item 2 glass fragments could not have come from the source of the Item 1 glass standard. Item 3 consists of two colorless glass fragments that have their full thickness and exhibit characteristics consistent with non-tempered float sheet (window) glass. Macroscopic, microscopic and instrumental examinations and comparisons of Items 1 and 3 revealed that these questioned glass fragments are like the glass standard in Item 1, with respect to their color, thickness, refractive index values and chemical characteristics. It is therefore concluded that the Item 3 glass fragments represented as having been recovered from the subject originated either from the broken bedroom window of the apartment or from another source of broken non-tempered float sheet glass having these same characteristics.</p>
PZYJKP	<p>The glass from item-3 (questioned glass fragments recovered from the suspect) and the item-1 (known glass fragments recovered from the broken bedroom windows) were consistent could have the same source. The glass from item-2 (questioned glass fragments recovered from the suspect) and the item-1 (known glass fragments recovered from the broken bedroom windows) were inconsistent and could not have the same source.</p>
Q8CQ3E	<p>Item 1 comprised two full thickness fragments of colourless annealed float glass collected from the victim's broken bedroom window (control glass). The fragments were found to have an average thickness of 2.97mm, an average refractive index of 1.5190 and were principally composed of the elements O, Si, Na, Ca, Mg, Al, S, K, Fe and Cu. Item 2 comprised two full thickness fragments of colourless annealed float glass recovered from the suspect. The fragments were found to have an average thickness of 3.12mm and an average refractive index of 1.5167. These fragments neither corresponded in thickness nor refractive index to the control glass (Item 1) and could not have originated from the victim's broken bedroom window (Item 1). Item 3 comprised two full thickness fragments of colourless annealed float glass recovered from the suspect. The fragments were found to have an average thickness of 2.97mm, an average refractive index of 1.5190 and were principally composed of the elements O, Si, Na, Ca, Mg, Al, S, K, Fe and Cu. These fragments corresponded in refractive index, appearance, thickness and bulk elemental composition to the control glass (Item 1). The results strongly support the proposition that these glass fragments recovered from the suspect (Item 3) originated from the victim's broken bedroom window (Item 1), rather than another source of glass.</p>
R3C3GP	<p>The glass fragments Item 1 and Item 3 are both float glasses, have a thickness of around 2.95 mm and cannot be differentiated by their refractive indices and their elemental composition. The glass from Item 2 is a float glass and has a thickness of around 3.08 mm. The glass differs in its refractive indices and in its elemental composition from Item 1. Item 1 and Item 3 cannot be differentiated. But the glass fragments Item 1 and Item 2 can be differentiated by their thickness, refractive indices and their elemental composition.</p>

TABLE 3

WebCode	Conclusions
RE4PMK	<p>METHODS: Items 1, 2, and 3 were examined visually and using a digital caliper, ultraviolet light, and the Glass Refractive Index Measurement system (GRIM3). It should be noted that this examination did not include elemental analysis. RESULTS AND INTERPRETATIONS: The Item 3 glass fragments were consistent with the Item 1 glass in color, type, thickness, temper, and refractive index. Based on the fragments examined, it was concluded that these fragments originated from either the broken glass source represented by Item 1 or another source of broken glass with the same properties (Level III – Association with Discriminating Characteristics). This type of conclusion was reached because other glass sheets or products produced with the same properties would also be indistinguishable. Despite the utilization of discriminating techniques, the chance of finding coincidental associations is higher when no elemental analysis is performed. Based on the fragments examined, the Item 2 glass fragments could not be associated with the Item 1 glass due to differences in thickness and refractive index (Exclusion/Elimination). TERMINOLOGY KEY FOR COMPARATIVE EXAMINATIONS: Level I - Physical/Fracture Match: Physical Fit is reached when the items that have been broken, torn, or separated exhibit physical features that correspond/re-align in a manner that is not expected to be replicated. Level II - Association with Highly Discriminating Characteristics: An association in which items could not be differentiated based on the examinations conducted. Therefore, the possibility that the items came from the same source cannot be eliminated. Additionally, the items share unusual characteristics that would rarely be expected to occur in the relevant population. This is the highest degree of association that can be determined in the absence of a Physical Fit. Level III - Association with Discriminating Characteristics: An association in which items could not be differentiated based on the examinations conducted. Therefore, the possibility that the items came from the same source cannot be eliminated. Other items have been manufactured or could occur in nature that would also be indistinguishable from the submitted items and could be encountered in the relevant population. The analytical techniques used in the analysis of these items can provide high levels of discrimination among natural and manufactured materials. This is considered a high degree of association. Level IV - Association with Limitations: An association in which items could not be differentiated based on the examinations conducted. Therefore, the possibility that the items came from the same source cannot be eliminated. As compared to the categories above, this type of association has decreased evidential value. For example, the items are more commonly encountered in the relevant population, minor variations were observed, or a complete analysis was not performed due to limited characteristics or sample size. Minor variations, for certain types of examinations, could be due to factors such as contamination of the sample(s) or having a sample of insufficient size to adequately assess heterogeneity of the entity from which it was derived. Inconclusive: No conclusion could be reached regarding an association or an elimination between the items. Exclusion with Limitations: The item exhibits differences from the comparison sample that support that it did not originate from the source, as represented by the comparison sample. An Exclusion/Elimination conclusion was not reached due to limiting factors, such as possible natural or manufactured source variations. Exclusion/Elimination: The items exhibit differences that demonstrate the items did not originate from the same source. Date(s) of testing: 07/11/2024 - 07/15/2024. Supporting examination documentation is maintained in the case file.</p>
RPPTW6	<p>Based on the analysis of triplicate 2-4 mg portions of glass fragments by Inductively Coupled Plasma – Mass Spectrometry the concentration of 8 elements in Item 2 were distinguishable from the concentration of those elements in Item 1. The concentrations of 47 elements in Item 3 were not distinguishable from the concentration of those elements in Item 1. Distinguishability is based on the sample average and 4 x the standard deviation. This criterion has been used in the published literature to provide the lowest combination of type 1</p>

TABLE 3

WebCode	Conclusions
	and 2 error rates [1]. Elemental concentrations are considered indistinguishable if the range generated by their average concentration ± 4 [standard deviation] (above the MQL) overlap. Opinions/Interpretations: Based on the results Item 2 could not have originated from Item 1 and Item 3 could have originated from Item 1.
RQT3LX	Glass fragments labeled as Item 2 differ in refractive index from the glass fragment labeled as Item 1, which means that they don't originate from the same source. The glass fragments labeled as Item 3 match the tested physico-chemical properties (color, thickness, elemental composition and RI) with the glass labeled as Item 1. Considering all the common characteristics, the glass samples from Item 1 and 3 most likely originate from the same source.
RRUGEF	The questioned glass fragments recovered from the suspect (item 2) were found to consist of two fragments of clear, colourless glass with the original faces present. This glass was found to have a different thickness to the glass recovered from the broken bedroom window (item 1) and therefore could not have originated from that source. The questioned glass fragments recovered from the suspect (item 3) were found to consist of two fragments of clear, colourless glass with the original faces present. In relation to thickness, colour, refractive index and elemental composition this glass was found to be indistinguishable to the glass from the broken bedroom window (item 1). Therefore these two glass samples may share a common origin.
TCXJM6	The Item 2 glass has different physical and optical properties and a different trace elemental content than the Item 1 glass. These two glass samples did not come from the same source. The Item 3 glass has similar physical and optical properties as well as similar trace elemental content as the Item 1 glass. These two glass samples could have come from the same source or different sources manufactured in a similar manner.
TK9L97	In my opinion, item 2 could not have originated from the control source in item 1. In my opinion, item 3 could have originated from the control source in item 1.
UA8KA7	The two (02) fragments of questioned glass recovered from the suspect (item 2) have not the same physical and chemical properties to the two (02) fragments of known glass recovered from the broken bedroom window (item 1), therefore, the two (02) fragments of questioned glass recovered from the suspect (item 2) have not originated from the glass of the broken bedroom window. The two (02) fragments of questioned glass recovered from the suspect (item 3) have the same physical and chemical properties to the two (02) fragments of known glass recovered from the broken bedroom window (item 1), therefore, the two (02) fragments of questioned glass recovered from the suspect (item 3) could have originated from the glass of the broken bedroom window or from another source exhibiting the same physical and chemical properties.
UWL678	The results give strong support to the hypothesis that Item 3 originates from the source Item 1. The hypothesis is held against the alternative, claiming that Item 3 has another origin/source, different from Item 1 (+3). The results give strong support to the hypothesis that Item 2 originates from a source different from Item 1. The hypothesis is held against the alternative, claiming that Item 2 has the same origin/source as Item 1 (-3).
UZHWCJ	Items 1, 2, and 3 each contain 2 pieces of colorless, tempered glass. Item 2 is dissimilar from item 1 in thickness and elemental composition; therefore, the glass pieces from item 2 did not originate from the same source as item 1, as represented by the examined pieces. Item 3 is similar to item 1 in thickness, elemental composition, and refractive index; therefore, item 3 could have originated from the same source as item 1 as represented by the examined pieces.
V9BNXH	[No Conclusions Reported.]

TABLE 3

WebCode	Conclusions
W4W7FZ	Compositionally, and by thickness, and color Item 2 is not consistent with Item 1 as the source. Compositionally, Item 3 is consistent with Item 1 as a source. However, Item 3 is colorless and ~0.5 mm thinner between float faces than Item 1, which has a slightly greenish tint.
W8WGCZ	RESULTS OF EXAMINATION/ANALYSIS: 1. Visual/Microscopic Examination for Characteristics of Glass. a) All six fragments from Laboratory items #1, 2, and 3 were observed to have two parallel original surfaces. b) All six fragments were probed for hardness using metal tweezers and examined for isotropism while mounted in a drop of water. c) All six fragments were found to be hard, isotropic, insoluble in water, and exhibited conchoidal fractures, which are all class characteristics of glass. 2. Comparison: a) Examination of Laboratory item #2 and comparison to Laboratory item #1 disclosed that they are different with respect to thickness and elemental composition. b) Examination of Laboratory item #3 and comparison to Laboratory item #1 disclosed that they are consistent and no exclusionary differences were observed with respect to color, appearance, thickness, response to UV light, elemental composition, and refractive index. INTERPRETATION OF RESULTS: 1. It is the opinion of the undersigned that Laboratory item #2 (questioned fragments Q1A and Q1B) could not have originated from the source represented by Laboratory item #1 (known fragments KA and KB). 2. It is the opinion of the undersigned that Laboratory item #3 (questioned fragments Q2A and Q2B) could have originated from the source represented by Laboratory item #1 (known fragments KA and KB) or from another source exhibiting all of the same analyzed characteristics.
WPCQC2	Item 3 could have originated from the same source as Item 1 based on the physical characteristics (thickness) and the trace elemental composition. However, Item 2 could not have originated from the same source as Item 1 since the thickness and elemental compositions are different from Item 1.
WYQNFR	Glass fragments (Item 3) from the suspect correspond to the broken bedroom window glass (Item 1). Glass fragments (Item 2) from the suspect differs from the broken bedroom window glass (Item 1).
X3G9N2	The questioned glass fragments recovered from the suspect (Item 3) can come from the broken bedroom window (Item 1) or from another glass material with the same characteristics. The questioned glass fragments recovered from the suspect (Item 2) don't come from the broken bedroom window (Item 1).
XBQX2Z	The recovered glass fragments from Item 2 were compared to the reference glass (Item 1) when they were found to be different in thickness. The recovered fragments in Item 2 have not come from the source as the reference glass in Item 1. The recovered glass fragments from Item 3 were compared to the reference glass (Item 1) when they were found to show agreement physical characteristics and Refractive Index. One fragment was examined further and found to show agreement in thermal history with the reference glass. The recovered fragments in Item 3 could have originated from the same source as the reference glass in Item 1. For the recovered fragments in Item 3 to have come from another source of glass, the alternative source would have to have the same physical characteristics, Refractive index, thermal history and also be freshly broken.
XNWLHA	The questioned glass fragments recovered from the suspect (Item 3) are similar in color, thickness, fluorescence, elemental composition and refractive index in comparison to the known glass fragments recovered from the broken bedroom window (Item 1). The glass fragments from Item 3 could have originated from the same glass source as Item 1 or any other broken glass source similar in color, thickness, fluorescence, elemental composition and refractive index. The questioned glass fragments recovered from the suspect (Item 2) are

TABLE 3

WebCode	Conclusions
	similar in color and fluorescence, but different in thickness, elemental composition and refractive index in comparison to the known glass fragments recovered from the broken bedroom window (Item 1). The glass fragments from Item 2 could not have originated from the same glass source as Item 1.
Y466ME	The above glass findings provide moderately strong support for the view that the matching glass (item 3) recovered from the suspect originated from the bedroom window (item 1), rather than from another source. Note: No inference on the activity that led to the presence of the glass can be made. The remaining questioned glass fragments (item 2) did not originate from the bedroom window (item 1), they originated from another source.
YCET2D	Two glass fragments (Item 2) are dissimilar in thickness to the glass fragments from the broken bedroom window (Item 1). It is our opinion that these fragments did not originate from the glass fragments from the broken bedroom window. Two glass fragments (Item 3) are similar in visual color, thickness, fluorescence, and elemental composition to the glass fragments from the broken bedroom window (Item 1). It is our opinion that these fragments could share a common origin to the glass fragments from the broken bedroom window. Please note refractive index comparison between the glass recovered from the suspect and the glass recovered from the broken bedroom window cannot be performed by our laboratory at this time. Item 1 was used as a comparison standard.
ZEYZZZ	Item 3 is similar to Item 1 in spectral ratio of elements using LIBS and in terms of thickness. Item 2 differs from Item 1 in spectral ratio of elements using LIBS and in terms of thickness.
ZRA7FA	Item 2 and Item 3 were examined to determine the presence of glass. Any glass fragments recovered were examined and compared to the glass found in Item 1 to determine if it could have originated from that source of broken glass. 1 – Glass from broken bedroom window. This item consists of two (2) colorless glass fragments with characteristics consistent with non-tempered float sheet (window) glass. Both fragments have their complete thickness. These fragments were used as standards for comparison purposes. 2 – Questioned glass fragments from suspect. Item 2 was examined for the presence of glass and two (2) colorless glass fragments were found. These fragments had characteristics consistent with non-tempered float sheet (window) glass. Macroscopic and microscopic examinations and comparisons revealed exclusionary differences between the questioned glass in Item 2 and the glass from the broken window in Item 1, with respect to refractive index values. It is therefore concluded that the glass fragments recovered from the suspect in Item 2 could not have come from the broken bedroom window as represented by the standard. 3 – Questioned glass fragments from suspect. Item 3 was examined for the presence of glass and two (2) colorless glass fragments were found. These fragments had characteristics consistent with non-tempered float sheet (window) glass. Macroscopic and microscopic examinations and comparisons revealed that they are like the glass standard from the broken window in Item 1, with respect to their color, thickness, refractive index values and chemical characteristics. It can therefore be concluded that the glass fragments retrieved from the suspect in Item 3 originated either from the broken bedroom window or another source of broken colorless non-tempered float sheet (window) glass having the same characteristics.

Additional Comments

TABLE 4

WebCode	Additional Comments
3WQP8E	The questioned glass Item 2 may be resubmitted for additional comparison(s), should a suspected source of similar glass become available. Methods of Analysis: Items analyzed using a combination of stereomicroscopy, high power and polarized light microscopy, and ultraviolet light examination. Micro X-ray Fluorescence Spectrometry ([micro]-XRF) was used to analyze elemental composition. An automated Glass Refractive Index Measurement system (GRIM) was used to analyze optical properties (refractive index) of one piece from each item. XRF and GRIM are standard instrumental techniques. XRF data was compared using spectral overlay and elemental ratio comparisons.
4NFNLD	An Association Scale for Trace Evidence would be included in the report.
7FEAE9	The thickness of glass fragments from item 2 differed from glass fragments from item 1 and item 3. Although accordingly internal procedure, LR calculation was introduced into quantitative element composition delivered by SEM/EDX clear differences in qualitative elemental composition were detected between item 1 and 2 vs Item 3 (i.e. lack of K for item 1 and 3 while presence of K for item 2).
DUVD3Q	The results of examination stated above would be accompanied by methods used, interpretation and limitations as well as access to underlying data as requested.
EXPR2Z	Refractive index comparison could not be performed by our laboratory at this time due to the GRIM 3 being currently out of service.
GDUZVK	In expressing the evidential significance of my findings, I have used the following scale: No support for either proposition, limited, moderate, moderately strong, strong, very strong and extremely strong support. It should be noted that this scale is logarithmic, rather than linear, such that each point on the scale (prior to 'extremely strong') is ten times greater than the previous one.
HJDM4V	Thickness results [mm]: Item 1: 2.978. Item 2: 3.116. Item 3: 2.970. nD results [RIU]: Item 1: 1.51880. Item 2: 1.51646. Item 3: 1.51880. nC results [RIU]: Item 1: 1.52057. Item 3: 1.52067. nF results [RIU]: Item 1: 1.51378. Item 3: 1.51386. Qualitative SEM/EDS analysis has found that Item 1 contained the following elements: Si, O, Ca, Mg, Na, and traces of Al and K. Item 3 contained the following elements: Si, O, Ca, Mg, Na, and traces of Al and K. Item 2 contained the following elements: Si, O, Ca, Mg, Na, Al, and K.
NW2EWL	Examinations on the glass in Items 1, 2 and 3 were performed macroscopically, and by use of stereomicroscopy, ultraviolet fluorescence, a micrometer for thickness measurements, and x-ray fluorescence spectrometry. Items 1 and 3 were examined further using a refractive index measurement system.
RPPTW6	[1] Trejos, Tatiana; Koons, Robert; Weis, Peter, Becker, Stefan; Berman, Ted; Dalpe, Claude; Duecking, Marc; Buscaglia, JoAnn; Ecker-Lumsdon, Tiffany; Ernst, Troy; Hanlon, Christopher; Heydon, Alex; Mooney, Kim; Nelson, Randall; Olsson, Kristine; Schenk, Emily; Palenik, Christopher; Pollock, Edward Chip; Rudell, David; Ryland, Scott; Tarifa, Anamary; Valadez, Melissa; Es, Andrew van; Zdanowicz, Vincent; and Almirall, Jose J. Anal. At. Spectrom., 2013, 28, 1270-1282.
XBQX2Z	Due to the fact that the fragments were provided, and not recovered within a search at the laboratory, this case would be reported at source level only.
XNWLHA	Chemical Analysis performed includes: Polarized Light Microscopy, Fluorescence, X-Ray Fluorescence Spectroscopy, and Refractive Index. Samples collected and/or analyzed during the examination and analysis of the items in this case (ex. glass slides) have been returned to and retained with the original item.

TABLE 4

WebCode	Additional Comments
Y466ME	As no timeline is listed for the incident/recovery of S/O clothing or details relating to the retentive properties of the S/O clothing it is not possible to evaluate the findings at activity level. A higher support level would likely be reported if the results could be evaluated at activity level vs source level.

-End of Report-
(Appendix may follow)

Test No. 24-5481: Glass Analysis

DATA MUST BE SUBMITTED BY **Aug. 05, 2024, 11:59 p.m. EDT** TO BE INCLUDED IN THE REPORT

Participant Code: U1234A

WebCode: ZW6XN7

The Accreditation Release section can be accessed by using the "Continue to Final Submission" button above. This information can be entered at any time prior to submitting to CTS.

Scenario:

Police are investigating a homicide. They determined the point of entry into the apartment to be through the broken bedroom window. Glass fragments were recovered from an area near the bedroom window. That same night, police apprehended a suspect and recovered glass fragments similar to those collected at the crime scene. Investigators are asking you to compare the glass fragments recovered from the suspect with the fragments recovered from the broken bedroom window and report your findings.

Please Note:

-Samples contained within each individual item are from a single source.

-CTS will not reproduce Interpretation Scales, Scale of Conclusions or Terminology Keys in the final report, please do not submit with the participant's data sheet.

Items Submitted (Sample Pack GL):

Item 1: Known glass fragments recovered from the broken bedroom window.

Item 2: Questioned glass fragments recovered from the suspect.

Item 3: Questioned glass fragments recovered from the suspect.

1.) Could the questioned glass fragments recovered from the suspect (Item 2 and Item 3) have originated from the broken bedroom window as represented by Item 1?

	Yes	No	Inconclusive
Item 2:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Item 3:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2.) Indicate the procedure used to examine the submitted items:

<input type="checkbox"/> nD	<u>Refractive Index:</u>	<input type="checkbox"/> nC	<u>UV Fluorescence:</u>	<input type="checkbox"/> Color	<input type="checkbox"/> Thickness
<input type="checkbox"/> nF	<input type="checkbox"/> Δ RI	<input type="checkbox"/> Long	<input type="checkbox"/> Short	<input type="checkbox"/> Density	
<u>Elemental Analysis:</u>					
<input type="checkbox"/> SEM/EDS	<input type="checkbox"/> XRS/XRF				
Other:	<input type="text"/>				

Please note: Any additional formatting applied in the free form space below will not transfer to the Summary Report and may cause your information to be illegible. This includes additional spacing and returns that present your responses in lists and tabular formats.

3.) What would be the wording of the Conclusions in your report?

4.) Additional Comments

RELEASE OF DATA TO ACCREDITATION BODIES

The Accreditation Release is accessed by pressing the "Continue to Final Submission" button online and can be completed at any time prior to submission to CTS.

CTS submits external proficiency test data directly to ANAB and/or A2LA. Please select one of the following statements to ensure your data is handled appropriately.

- This participant's data is intended for submission to ANAB and/or A2LA. (Accreditation Release section below must be completed.)
- This participant's data is not intended for submission to ANAB and/or A2LA.

Have the laboratory's designated individual complete the following steps only if your laboratory is accredited in this testing/calibration discipline by one or more of the following Accreditation Bodies.

Step 1: Provide the applicable Accreditation Certificate Number(s) for your laboratory.

ANAB Certificate No.

A2LA Certificate No.

Step 2: Complete the Laboratory Identifying Information in its entirety.

Authorized Contact Person and Title

Laboratory Name

Location (City/State)