Collaborative Testing Services, Inc
FORENSIC TESTING PROGRAM

Glass Analysis Test No. 18-548 Summary Report

Each participant received a sample set consisting of one set of known glass fragments (Item 1) and two sets of questioned glass particles (Items 2 and 3). Participants were requested to analyze and compare these and report their findings. Data were returned from 92 participants and are compiled into the following tables:

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 consisted of three samples of glass fragments, one Known (Item 1) and two Questioned (Items 2 & 3). Items 1 and 2 were from the same piece of picture frame glass, while Item 3 was from a different piece of picture frame glass. Examiners were instructed to examine the questioned glass particles and determine if they could have originated from the same source as the Known recovered glass fragments (Item 1).

SAMPLE PREPARATION-
The glass was examined for defects and then broken. Differing items were processed and packaged separately from each other to prevent cross-contamination.

ITEMS 1 and 2 (ASSOCIATION): For the Known Item 1 samples, two glass fragments approximately 1/8" x 1/8" in size were selected and packaged in a glassine bag and then a pre-labeled Item 1 coin envelope. For the questioned Item 2 samples, two glass particles approximately 1/16" x 1/16" in size were selected and packaged in a glassine bag and then a pre-labeled Item 2 coin envelope. Items 1 and 2 were taken in close spatial proximity to one another and were kept together as an identification group and packaged into the sample set as described below.

ITEM 3 (ELIMINATION): For the Questioned Item 3 samples, two glass particles approximately 1/16" x 1/16" in size were selected and packaged in a glassine bag and then a pre-labeled Item 3 coin envelope. Item 3 was further packaged into the sample set as described below.

SAMPLE SET ASSEMBLY: For each sample set, an Item 1 and Item 2 from the same association group were placed in a pre-labeled envelope along with an Item 3. The sample pack was sealed with invisible tape. Once verification was completed, all sample packs were further sealed with a piece of evidence tape and initialed "CTS".

The average refractive indices for the glass as reported by preliminary testing and predistribution laboratories are as follows: Item 1 RI = 1.52222, Item 2 RI = 1.52222, and Item 3 RI = 1.51560.

VERIFICATION: All three predistribution laboratories reported the expected association and elimination results. The methods employed by the predistribution laboratories included refractive index nD, UV fluorescence short and long, color, thickness, Inductively Coupled Plasma Spectrometry, XRS/XRF, and SEM/EDS.

Summary Comments

This test was designed to allow participants to assess their proficiency in the examination, comparison, and interpretation of glass samples. Each sample set consisted of three samples of glass, one known (Item 1) and two questioned (Items 2 and 3). Items 1 and 2 were from the same piece of picture frame glass, while Item 3 was from a different piece of picture frame glass. Participants were requested to determine if either set of questioned particles could have come from the known source. (Refer to the Manufacturer's Information for preparation details.)

Of the 92 participants that reported results, 91 (98.9%) reported that the Item 2 glass particles could have originated from the Item 1 known glass sample and the Item 3 glass particles could not have originated from the Item 1 known glass sample. The remaining participant reported that both the Item 2 and Item 3 glass particles could not have originated from the Item 1 known glass sample.

The most commonly used methods of analysis were thickness, refractive index (nD), short UV, and color.

Examination Results

Could the questioned glass particles in Items 2 and/or 3 have originated from the victim's jewelry box as represented by Item 1?

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
22AQ63	Yes	No	EYFLTG	Yes	No
2ANR9H	Yes	No	F6KJ3L	Yes	No
2JQUQU	Yes	No	FDHCBF	Yes	No
2K2WB8	Yes	No	FLP4LV	Yes	No
33HD28	Yes	No	GFJPFK	Yes	No
3EWG6W	Yes	No	GNVNAV	Yes	No
3PYTJY	Yes	No	H3C4PZ	Yes	No
48RT9A	Yes	No	H9W9FF	Yes	No
4EEG7Z	Yes	No	HG7N7N	Yes	No
4KE6ER	Yes	No	HXERLM	Yes	No
4YV3JT	Yes	No	J7LN6K	Yes	No
6BQN84	Yes	No	JE2H6M	Yes	No
6KTV33	Yes	No	JV7PJP	Yes	No
6RAKLB	Yes	No	JWJGAK	Yes	No
6Z7EKV	Yes	No	K99MWN	Yes	No
7MDZDL	Yes	No	KFBP8F	Yes	No
7MUG8E	Yes	No	L7CNXF	Yes	No
8A7RR9	Yes	No	LL92EW	Yes	No
8APHXM	Yes	No	LVYJUQ	Yes	No
8LJYMN	Yes	No	MF3L9L	Yes	No
8V6T7X	Yes	No	MFGX3K	Yes	No
9C746Z	Yes	No	MNT6NF	Yes	No
9K3UW3	Yes	No	MXX2NC	Yes	No
9UM9QR	Yes	No	N38VZM	Yes	No
AYW233	Yes	No	PFV4EF	Yes	No
BQ4V4A	Yes	No	PLYZ7R	Yes	No
C3T8WY	Yes	No	PTLN4J	Yes	No
CFDTWY	Yes	No	PUPNV3	Yes	No
CJGPJ9	Yes	No	Q4Z6BF	Yes	No
CKPWQ8	Yes	No	Q8FX29	Yes	No
DJ8ANJ	Yes	No	Q9PP94	Yes	No
DJTLMR	Yes	No	QFULZG	Yes	No
DQRB4W	Yes	No	QNYQNR	Yes	No
DVMTQN	Yes	No	RCH9M8	Yes	No
E26RBT	Yes	No	RLQZYN	Yes	No
EMPQGN	Yes	No	TFKLRC	Yes	No

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
TMXKDB	Yes	No			
TNWPU6	Yes	No			
U2EYUF	Yes	No			
U9VB8F	Yes	No			
UELKJZ	Yes	No			
URCGLX	Yes	No			
V4WEZ2	Yes	No			
VBMMT8	Yes	No			
VFD4Y7	Yes	No			
VU9KN4	Yes	No			
WEDKCV	Yes	No			
WHX89P	Yes	No			
WVZXQM	Yes	No			
WYG7C2	Yes	No			
XHCB28	Yes	No			
XWEHGC	Yes	No			
Y7WNKT	Yes	No			
Y83BXX	No	No			
Z2WYE7	Yes	No			
ZE6HC2	Yes	No			

Response Summary

Total Participants: 92

Could the questioned glass particles in Items 2 and/or 3 have originated from the victim's jewelry box as represented by Item 1?

Response		Item 2		Item 3	
	Yes	91	*(98.9%)*	0	*(0.0%)*
	No	1	*(1.1%)*	92	*(100.0%)*
	Inconclusive	0	*(0.0%)*	0	*(0.0%)*

Examination Procedures

TABLE 2

	Refractive Index							Elemental		UV		
WebCode	nD	nF	nC	ΔRI	Color	Density	Thickness	SEM/ EDS	XRS/ XRF	Long	Short	Other
22AQ63	✓				✓		✓		✓			
2ANR9H	✓				✓		✓	✓		✓	✓	
2JQUQU	✓			✓	✓		✓			✓	✓	
2K2WB8	✓						✓					LA-ICP-MS
33HD28	✓				✓		✓			✓	✓	
3EWG6W					✓	✓	✓	✓	✓			GRIMM
3PYTJY	✓				✓		✓	✓			✓	Polarized Light Microscopy
48RT9A	✓				✓		✓				✓	
4EEG7Z	✓				✓	✓	✓		✓	✓	✓	
4KE6ER												Laser Ablation-ICP/MS
4YV3JT												LA-ICPMS
6BQN84	✓				✓		✓		✓		✓	
6KTV33	✓				✓		✓		✓	✓	✓	Foster & Freeman GRIM3 (Refractive index measurement)
6RAKLB	✓				✓		✓		✓		✓	
6Z7EKV	✓						✓	✓		✓	✓	
7MDZDL	✓				✓	✓	✓		✓	✓	✓	
7MUG8E												LA-ICPMS
8A7RR9	✓	✓	✓		✓	✓	✓			✓	✓	
8APHXM				✓			✓					
8LJYMN				✓	✓		✓		✓			LA-ICP-MS
8V6T7X	✓				✓	✓	✓		✓	✓	✓	
9C746Z	✓	✓	✓		✓	✓	✓				✓	
9K3UW3	✓				✓		✓	✓				
9UM9QR												Raman spectroscopy
AYW233				✓			✓				✓	
BQ4V4A	✓				✓		✓			✓	✓	ICP-OES

TABLE 2

	Refractive Index							Elemental		UV		
WebCode	nD	nF	nC	ΔRI	Color	Density	Thickness	SEM/ EDS	XRS/ XRF	Long	Short	Other
C3T8WY	✓			✓	✓		✓			✓	✓	LA-ICP-MS
CFDTWY	✓			✓			✓				✓	
CJGPJ9												laser ablation-ICP_MS
CKPWQ8	✓			✓	✓		✓	✓			✓	
DJ8ANJ												LASER ABLATION ICP-MS
DJTLMR	✓				✓		✓				✓	
DQRB4W				✓	✓		✓		✓			
DVMTQN	✓				✓		✓	✓		✓	✓	
E26RBT	✓				✓		✓		✓	✓	✓	
EMPQGN	✓				✓		✓			✓	✓	LA-ICP-MS
EYFLTG												LASER ABLATION ICP-MS
F6KJ3L	✓				✓		✓		✓	✓	✓	
FDHCBF	✓				✓		✓	✓			✓	
FLP4LV	✓						✓	✓		✓	✓	
GFJPFK	✓				✓		✓		✓		✓	
GNVNAV	✓				✓		✓	✓			✓	LA-ICPMS
H3C4PZ	✓				✓		✓		✓	✓	✓	
H9W9FF												Laser Ablation ICP-MS
HG7N7N	✓			✓	✓		✓			✓		
HXERLM	✓				✓		✓		✓		✓	
J7LN6K	✓				✓		✓			✓	✓	
JE2H6M	✓			✓	✓		✓					
JV7PJP	✓				✓	✓	✓	✓		✓	✓	
JWJGAK	✓				✓		✓		✓	✓	✓	
K99MWN	✓				✓		✓		✓	✓	✓	
KFBP8F	✓				✓		✓			✓	✓	ICP-MS
L7CNXF	✓				✓		✓			✓	✓	
LL92EW	✓				✓		✓				✓	LIBS, LA-ICP-MS

TABLE 2

	Refractive Index							Elemental		UV		
WebCode	nD	nF	nC	ΔRI	Color	Density	Thickness	SEM/ EDS	XRS/ XRF	Long	Short	Other
LVYJUQ	✓				✓		✓		✓		✓	
MF3L9L	✓				✓		✓			✓	✓	
MFGX3K					✓		✓	✓		✓		
MNT6NF	✓				✓		✓		✓	✓	✓	
MXX2NC						✓			✓			LIBS
N38VZM	✓				✓		✓	✓		✓	✓	
PFV4EF	✓				✓		✓		✓	✓	✓	
PLYZ7R	✓				✓		✓		✓	✓	✓	
PTLN4J	✓				✓		✓	✓		✓	✓	
PUPNV3								✓	✓			
Q4Z6BF				✓			✓	✓		✓	✓	
Q8FX29	✓				✓		✓			✓	✓	
Q9PP94	✓			✓			✓	✓			✓	
QFULZG	✓				✓	✓	✓	✓		✓	✓	
QNYQNR	✓				✓		✓		✓	✓	✓	Morphology via stereomicroscopy
RCH9M8	✓	✓					✓				✓	
RLQZYN	✓				✓		✓		✓	✓	✓	
TFKLRC					✓		✓				✓	LA-ICP-MS
TMXKDB							✓	✓				
TNWPU6	✓			✓	✓		✓		✓		✓	
U2EYUF	✓						✓		✓			Microscopic and Visual Examinations
U9VB8F	✓						✓			✓	✓	
UELKJZ	✓											
URCGLX	✓						✓	✓				
V4WEZ2												LASER ABLATION ICP-MS
VBMMT8	✓				✓		✓		✓	✓	✓	PLM
VFD4Y7	✓											
VU9KN4				✓	✓		✓					

TABLE 2

	Refractive Index							Elemental		UV		
WebCode	nD	nF	nC	ΔRI	Color	Density	Thickness	SEM/ EDS	XRS/ XRF	Long	Short	Other
WEDKCV	✓			✓	✓		✓	✓			✓	
WHX89P												LA-ICPMS
WVZXQM	✓				✓		✓				✓	Inductively Coupled Plasma - Optical Emission Spectrometry
WYG7C2	✓				✓		✓		✓	✓	✓	
XHCB28	✓	✓	✓		✓		✓			✓	✓	Polarized light microscopy
XWEHGC	✓				✓		✓			✓	✓	
Y7WNKT	✓						✓			✓	✓	
Y83BXX												ICP-MS
Z2WYE7												Inductively Coupled Plasma – Mass Spectrometry
ZE6HC2							✓		✓			

Response Summary

	Refractive Index							Elemental		UV	
Participants	nD	nF	nC	ΔRI	Color	Density	Thickness	SEM/ EDS	XRS/ XRF	Long	Short
92	67	4	3	15	61	9	76	21	30	42	61
Percent	*73%*	*4%*	*3%*	*16%*	*66%*	*10%*	*83%*	*23%*	*33%*	*46%*	*66%*

Conclusions

TABLE 3

WebCode	Conclusions
22AQ63	It was determined utilizing visual examination and measurement, Glass Refractive Index Measurement System (GRIM3), and X-Ray Fluorescence that the glass samples from item 1 and item 2 exhibit consistent color, thickness, refractive index and elemental composition. Therefore, based on those characteristics the known sample from item 1 cannot be eliminated as being the source of the questioned glass from item 2. It was determined utilizing visual examination and measurement, Glass Refractive Index Measurement System (GRIM3), and X-Ray Fluorescence that the glass samples from item 1 and item 3 exhibit dissimilar thickness, refractive index and elemental composition. Therefore, based on those characteristics the known sample from item 1 can be eliminated as being the source of the questioned glass from item 3.
2ANR9H	The glass fragments recovered from the suspect’s car seat (Item 2) were consistent in physical properties, refractive index, and elemental composition with the known glass sample from the victim’s jewelry box (Item 1). The glass fragments from Item 2 could have originated from the broken glass represented by Item 1 or another source of broken glass with the same properties. The glass fragments recovered from the suspect’s backpack (Item 3) were dissimilar to the known glass sample from the victim’s jewelry box (Item 1) in physical properties.
2JQUQU	In our opinion, the two glass fragments recovered from the car seat could have originated from the jewelry box. For these fragments to have originated from a different glass source, this alternative glass source would have to be float, colourless, non-toughened and bear a similar thickness and refractive index to the glass from the jewelry box. The two glass fragments recovered from the backpack did not originate from the jewelry box.
2K2WB8	The fragment of known glass taken from the victim's jewelry box "Item 1" and particles of questioned glass recvovered from the suspect's car seat "Item 2" exhibit the same results in all investigated chemical composition and physical properties. Both of them are significantly different from "Item 3".
33HD28	Two particles of glass recovered from the suspect's car seat (Item 2) are similar in visual color, thickness, fluorescence, and refractive index to the fragments of glass from the victim's jewelry box. Please note trace elemental comparison between the glass from the suspect's car seat and the glass from the victim's jewelry box cannot be performed by our laboratory at this time. It is our opinion that these particles of glass recovered from the suspect's car seat could share a common origin to the fragments of glass from the victim's jewelry box. Two particles of glass recovered from the suspect's backpack (Item 3) are dissimilar in fluorescence and refractive index to the fragments of glass from the victim's jewelry box. It is our opinion that these particles of glass recovered from the suspect's backpack did not originate to the fragments of glass from the victim's jewelry box.
3EWG6W	Item 2 could have originated from Item 1. Item 3 could not have originated from Item 1.
3PYTJY	The glass in Item 2 (suspect's car seat)was visually, microscopically and instrumentally (refractive index and elemental composition) consistent with the known glass in Item 1 (victim's jewelry box). This indicates that the glass in Items 1 and 2 could share a common origin. The glass in item 3 (suspect's backpack) was visually and instrumentally different from the glass in Item 1. This indicates that the glass in Items 1 and 3 do not share a common origin.
48RT9A	In my opinion, the findings support an association between the glass recovered from the suspect's car seat (Item 2) and the glass from the victim's jewellery box (Item 1). It is also my opinion that there is no evidence of an association between the glass recovered from the

TABLE 3

WebCode	Conclusions
	suspect's backpack (Item 3) and the glass from the victim's jewellery box.
4EEG7Z	The questioned glass in Item 2 was identical to the known glass in Item 1 in optical, physical, and elemental properties. This means the glass recovered from the suspect's car seat could have come from the jewelry box. The questioned glass in Item 3 was different from the known glass in Item 1. This means that the glass recovered from the backpack did not come from the jewelry box.
4KE6ER	The elemental composition of the glass particles in Items 1 and 2 are indistinguishable. Therefore they could be from the same origin. The elemental composition of the glass particles in Items 1 and 3 are distinguishable. Therefore they could not be from the same origin.
4YV3JT	Chemical composition of item 1 and item 2 are indistinguishable thus the two items could have originated from the same source. Chemical composition of item 1 and 3 are distinguishable, therefore they could not be from the same source.
6BQN84	Item 1 is similar in all examined characteristics to item 2. Item 2 could have come from the same source as item 1, or from another source of glass with similar measured characteristics. Item 1 is excluded as the source of item 3.
6KTV33	Examination of questioned glass fragment Q1 (from lab item #2) and comparison to known glass fragment K1 (from lab item #1) disclosed that they are consistent and no discriminating differences were observed with respect to color, appearance, thickness, response to UV light, elemental composition and refractive index. It is my opinion that the questioned glass fragment Q1 (from lab item #2) could have originated from the same source as represented by the known glass fragment K1 (from lab item #1) or from another source exhibiting all of the same analyzed characteristics. Examination of questioned glass fragments Q3 & Q4 (lab item #3) and comparison to known glass fragments K1 & K2 (lab item #1) disclosed that they are different with respect to their thickness and response to UV light. It is my opinion that the questioned glass fragments Q3 & Q4 (lab item #3) could not have originated from the source represented by the known glass fragments K1 & K2 (lab item #1)
6RAKLB	The glass in Item 2 was found to be consistent in physical and chemical composition with the glass in Item 1. Therefore, the glass in Item 2 may have originated from the same source as the glass in Item 1. The glass in Item 3 was found to be dissimilar to the glass in Item 1.
6Z7EKV	Item 1: The colorless glass standard was analyzed for comparison to items 2 and 3. Item 2: Two pieces of colorless glass with two manufactured sides on each were found. In the sample analyzed, the unknown glass "from the suspect's car seat" either originated from the standard glass (item 1) "from the victim's jewelry box" or another source of broken glass possessing the same distinct physical and chemical characteristics. Item 3: Two pieces of colorless glass with two manufactured sides on each were found. In the sample analyzed, the unknown glass "from the suspect's backpack" and the standard glass (item 1) "from the victim's jewelry box" are not the same in physical or chemical characteristics. The unknown glass "from the suspect's backpack" could not have originated from the standard.
7MDZDL	The particles of questioned glass recovered from the suspect's car seat (Item 2) could have been originated from the victim's jewelry box (Item 1) because of the similarities of their physical properties and chemical composition. The particles of questioned glass recovered from the suspect's backpack (Item 3) could not have been originated from the victim's jewelry box (Item 1) because of the differences of their physical properties and chemical composition.
7MUG8E	3.1 The chemical composition of the questioned glass particles in Items 2 is identical to the chemical composition of glass particles in Item 1 and therefore items 1 and 2 could have the same origin. 3.2 The chemical composition of the questioned glass particles in Items 3 is not

TABLE 3

WebCode	Conclusions
	identical to the chemical composition of glass particles in Item 1 and therefore items 1 and 3 could not have the same origin.
8A7RR9	The glass in Items 1 and 2, could have originated from the same source. The glass in Items 1 and 3, did not originate from the same source.
8APHXM	Our findings give moderat to strong support for the hypotehsis that Item 2 originate from the source Item 1. This hypotehsis is held against the alternative, claiming that Item 2 has another origin/source, different from Item 1. Our findings give extreemly strong support to the hypotehsis that Item 3 originate from a source different from Item 1. This hypothesis is held against the alternative, claiming that Item 3 has the same origin/source as Item 1.
8LJYMN	Item 1 and Item 2 showed the significantly similar relative amount for Mg, Al, K, Ca, and Fe, whereas Item 1 and Item 3 showed the different relative amount for Mg, Al, K, Ca, and Fe. In addition, Item 1 and Item 2 showed the similar refractive index, but Item 1 and Item 3 showed the significantly different refractive index. Therefore, it is concluded that Item 1 and Item 2 could have originated from the same source while Item 1 and Item 3 could have originated from the different source.
8V6T7X	The glass found in Item 2 was identical to the glass in Item 1 in optical, physical, and elemental properties. This means the glass collected from the suspect's car seat could have come from the the victim's jewelry box. The glass found in Item 3 was different from the glass in Item 1. This means the glass collected from the suspect's backpack did not come from the victim's jewelry box.
9C746Z	The glass in Item 2 is similar in color, type, UV fluorescence, thickness, density and refractive index to the glass in Item 1. The glass in Item 2 could have originated from the same source as the glass in Item 1. The glass in Item 3 is similar in color, type and thickness to the glass in Item 1 but dissimilar in UV fluorescence, density and refractive index to the glass in Item 1. The glass in Item 3 did not originate from the same source as the glass in Item 1.
9K3UW3	The known glass sample in item 1 comprised two pieces of colourless glass fragments. The questioned glass sample in item 2 recovered from the suspect's car seat comprised two pieces of colourless particles, agreeing in colour, refractive index and elemental composition with the known glass item 1, suggesting that they could have originated from the same source. The recovered glass particles in item 3 were found to agree in colour but differ in refractive index with the known glass sample item 1, suggesting that they did not originate from the same source.
9UM9QR	The results show that item 1 and 2 could have been originated from the same source. There is no evidence that item 3 and item 1 can be from the same source.
AYW233	In my opinion, the glass evidence supports the proposition that the glass recovered from the car seat (Item 2) has originated from the jewelry box (Item 1), however another source with similar physical characteristics can not be excluded. In my opinion, the glass evidence does not support the proposition that the glass recovered from the backpack (Item 3) has originated from the jewelry box (Item 1)
BQ4V4A	Glass recovered from the debris from the car seat (Item 2) is indistinguishable in the observed or measured physical and optical properties and in elemental composition from the glass from the jewelry box as represented by Item 1. Therefore the glass recovered from the car seat (Item 2) either originated from the jewelry box as represented by Item 1, or from another source(s) of broken glass indistinguishable in all of the measured or observed physical properties, refractive index, and elemental composition. Glass recovered from the debris from the backpack (Item 3) is different than the glass from the jewelry box as represented by Item 1. Therefore the glass

TABLE 3

WebCode	Conclusions
	from the jewelry box as represented by Item 1 is eliminated as a possible source of the glass recovered from the debris from the backpack (Item 3).
C3T8WY	The two pieces of glass from the car seat (item 2) cannot be excluded as having come from the same source as the broken glass from the jewelry box, as represented by item 1. Therefore, these two pieces of glass either came from the jewelry box or from another source or sources of glass indistinguishable from item 1 with respect to the properties listed in the results. The broken glass from the backpack (item 3) did not come from the same source as the broken glass from the jewelry box, as represented by item 1.
CFDTWY	The results of this examination provide support for the proposition that the fragments of glass in item 2 could have originated from the source represented by item 1. The fragments of glass in item 3 did not originate from the source represented by item 1.
CJGPJ9	The chemical compostion of Item1 is similar to the chemical compostion of Item 2. Therefore they could have come from the same origin.The chemical compostion of Item1 is different to the chemical compostion of Item 3. Therefore they could not have come from the same origin.
CKPWQ8	The results of the examination give strong support for the hypothesis that the glass particles in Item 2 originate from the broken glass in the jewelry box as represented by Item 1 (Level +3). The results of the examination give extremley strong support for the hypothesis that the glass particles in Item 3 do not originate from the broken glass in the jewelry box as represented by Item 1 (Level -4).
DJ8ANJ	6.1 The chemical composition of iTEM 2 is consistent with the chemical composition of ITEM 1. 6.2 Therefore ITEM 1 and item 2 could have the same origin. 6.3 The chemical composition of item 3 is not consistent with the chemical composition of item 1. 6.4 Therefore item 1 and item 3 could not have the same origin.
DJTLMR	The glass fragments Item 1 and Item 2 are both float glasses and have a thickness of around 1.89 - 1.90 mm. The glass from Item 3 has a thickness of around 1.96 - 1.97 mm and shows no fluorescence on the surfaces in the UV-light. Item 3 and Item 1 also differ in their refractive indices. The glass fragments Item 3 and Item 2 cannot be diffrentiated by their refractive indices, their thickness and color. Therefor the questioned glass particles in Item 2 may have originated from the victim's jewelry box (Item 1).
DQRB4W	The RI values are significantly different in case of Item1 (1.52220) and Item3 (1.51563). In case of Item2 (1.52219) and Item1 the RI value is the same. In case of the elemental analysis the most obvious diffences are in the amounts of Mg, K, Ca and Fe between Item1 and Item3.
DVMTQN	The questioned glass in item 2 was visually, microscopically, and instrumentally (refractive index and elemental composition) consistent with the known glass in item 1. This indicates that the glass in item 2 could have originated from the glass in item 1. The questioned glass in item 3 was different from the known glass in item 1 with respect to thickness, fluorescence, refractive index, and elemental composition. This indicates that the glass in item 3 did not originate from the glass in item 1.
E26RBT	RESULTS OF EXAMINATION/ANALYSIS 1. Visual/Microscopic Observations a. All six fragments were observed to have two parallel original surfaces. 2. Examination for Characteristics of Glass a. Fragments 1A, 1B, 2A, 2B, 3A, and 3B were probed with metal tweezers, tested for solubility in water, and examined for isotropism with the aid of a polarized light microscope (PLM) while mounted in a drop of water. b. All six fragments were found to be hard, isotropic, insoluble in water, and exhibited conchoidal fractures, which are all class characteristics of glass. 3. Comparison a. Examination of the fragments 2A and 2B and comparison to the fragments 1A and 1B disclosed that they are consistent and no

TABLE 3

WebCode	Conclusions
	discriminating differences were observed with respect to color, appearance, thickness between original parallel surfaces, response to UV light, elemental composition, and refractive index. b. Examination of the fragments 3A and 3B and comparison to the fragments 1A and 1B disclosed that they are different with respect to thickness between original parallel surfaces and response to UV light. INTERPRETATION OF RESULTS 1. It is the opinion of the undersigned that the fragments 2A and 2B could have originated from the same source as the fragments 1A and 1B or from another source exhibiting all of the same analyzed characteristics. 2. It is the opinion of the undersigned that the fragments 3A and 3B could not have originated from the source as represented by the fragments 1A and 1B.
EMPQGN	The questioned glass marked “Item 3” did not originate from the same source as the control glass marked “Item 1”. The questioned glass marked “Item 2” was very likely to have originated from the same source as the control glass marked “Item 1”; other sources of glass with similar characteristics are limited.
EYFLTG	As a result of my examination I determined that: 3.1 The chemical composition of item 1 is indistinguishable from the chemical composition of item 2 therefore they could have the same origin. 3.2 The chemical composition of item 1 is distinguishable from the chemical composition of item 3 therefore they could not have the same origin.
F6KJ3L	The two particles of questioned glass recovered from the suspect's car seat (item 2) can come from the broken glass of the victim's jewelry box (item1) or from another glass material with the same characteristics. The particles of questioned glass recovered from the suspect's backpack (item 3) are different from the two fragments of known glass from the victim's jewelry box (item 1). They don't come from the same origin.
FDHCBF	Examination and comparison of Item 2 with Item 1 revealed the items to be glass that were similar in all measured physical and optical properties and elemental composition. Items 1 and 2 could have come from the same source or from other glass with the same properties. Examination and comparison of Item 3 with Item 1 revealed the items to be glass that were dissimilar in optical properties. Items 1 and 3 could not have come from the same source.
FLP4LV	I formed the opinion based on the techniques used, that the glass fragments recovered from the suspect’s car seat had the same thickness, appearance, elemental composition and refractive index as the control glass fragments collected from the victim’s jewellery box and could have originated from it. I also formed the opinion based on the techniques used, that the glass fragments recovered from the suspect’s backpack had a different thickness and refractive index to the control glass fragments collected from the victim’s jewellery box and could not have originated from it.
GFJPFK	Fragments from Exhibits 2 and 3 were examined and compared to the known glass submitted as Exhibit 1 using visual observations, thickness, UV fluorescence, x-ray fluorescence spectrometry, and the Glass Refractive Index Measurement (GRIM3), where applicable, to determine if these fragments and the known glass in Exhibit 1 could share a common origin. Results/Conclusions: The fragments of glass in Exhibit 2 and the known glass in Exhibit 1 exhibited similar characteristics using the techniques described above. The fragments in Exhibits 1 and 2 could share a common origin. The fragments of glass in Exhibit 3 and the known glass in Exhibit 1 were dissimilar in respect to UV fluorescence. The fragments in Exhibit 1 and 3 could not have shared a common origin.
GNVNAV	Item 1 comprised two full thickness fragments of colourless annealed float glass collected from the victim’s jewellery box (control glass). The fragments were found to have an average thickness of 1.91mm, an average refractive index of 1.5224 and were principally composed of the elements O, Si, Ca, Na, Mg, Al and K. Item 2 comprised two full thickness fragments of

TABLE 3

WebCode	Conclusions
	colourless annealed float glass recovered from the suspect's car seat. One fragment was found to have a thickness of 1.92mm, a refractive index of 1.5223 and was principally composed of the elements O, Si, Ca, Na, Mg, Al and K. The other fragment was found to have a thickness of 1.92mm, a refractive index of 1.5224 and was principally composed of the elements O, Si, Ca, Na, Mg, Al and K. These fragments statistically corresponded in refractive index and corresponded in appearance, thickness, gross elemental composition and trace elemental concentrations to the control glass (Item 1). These results strongly support the proposition that the glass fragments recovered from the suspect's car seat (Item 2) originated from the victim's jewellery box (Item 1). Item 3 comprised two full thickness fragments of colourless annealed glass recovered from the suspect's backpack. Both fragments were was found to have a thickness of 1.98mm and a refractive index of 1.5157. These fragments did not correspond in thickness or refractive index to the control glass (Item 1) and could not have originated from the victim's jewellery box (Item 1).
H3C4PZ	CONCLUSIONS: Two glass fragments recovered from the suspect's car seat (Item 2) either originated from the jewelry box (Item 1) or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics. Two glass fragments recovered from the suspect's backpack (Item 3) did not originate from the jewelry box (Item 1). RESULTS: Two questioned glass fragments recovered from the suspect's car seat (Item 2) and two questioned glass fragments recovered from the suspect's backpack (Item 3) were examined for the purpose of determining whether or not they are like the known glass standard from the jewelry box (Item 1). The known glass standard from the jewelry box (Item 1) is colorless, non-tempered, sheet, float glass. Examination and comparison of the two questioned glass fragments recovered from the suspect's car seat (Item 2) with the known glass standard from the jewelry box (Item 1) reveals they are alike with respect to physical, optical, and chemical characteristics. It is therefore concluded that these two questioned glass fragments recovered from the suspect's car seat (Item 2) either originated from the jewelry box (Item 1) or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics. Examination and comparison of the two questioned glass fragments recovered from the suspect's backpack (Item 3) with the known glass standard from the jewelry box (Item 1) reveals they are dissimilar with respect to chemical characteristics. It is therefore concluded that these two questioned glass fragments recovered from the suspect's backpack (Item 3) did not originate from the jewelry box (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.
H9W9FF	As a result of my examination I determined that: 1.1 The chemical composition of the glass fragments of "Item1" is consistent with the chemical composition of the glass fragments of "Item 2". Therefore "Item1" cannot be excluded as a source of the glass fragments "Item 2". 2.2 The chemical composition of the glass fragments of "Item 3" is different from the chemical composition of the glass fragments of "Item 1". Therefore "Item 1"can be excluded as a source of the glass fragments "Item 3".
HG7N7N	Particles of questioned glass recovered from the suspect's car seat (Item 2) could have a common origin with glass fragments of known glass taken from the victim's jewelry box (Item 1). Particles of questioned glass from the suspect's backpack (Item 3) are different from glass fragments of known glass (Item 1).
HXERLM	Questioned clear glass fragments recovered from a car seat (Item 2) and from a backpack (Item 3) were compared to known clear glass fragments from a jewelry box (Item 1) using physical characteristics, UV fluorescence, refractive index measurements, and elemental analysis by X-Ray Fluorescence (XRF). The questioned glass fragments from the car seat was

TABLE 3

WebCode	Conclusions
	similar in color, thickness, type (float, non-tempered), UV fluorescence, refractive index, and elemental composition to the known glass. The questioned glass fragments from the car seat originated from either the jewelry box represented by Item 1 or from another broken glass source with indistinguishable properties. Because similar glass has been manufactured that would be indistinguishable from the submitted evidence, an individual source cannot be determined. The questioned glass fragments from the backpack differed from the known glass in UV fluorescence, refractive index measurements, and elemental composition. The questioned glass fragments from the backpack did not originate from the jewelry box represented by Item 1.
J7LN6K	The glass from questioned "item 2" was found to be consistent with the known glass "item 1". Therefore, the glass from the "item 2" could have come from the same source as the glass from "item 1". The glass from questioned "item 3" was found to be inconsistent with the known glass "item 1". Therefore, the glass from the "item 3" could not have come from the same source as the glass from "item 1".
JE2H6M	The clear glass recovered from the suspect's car seat (item 2) matched, with regard to refractive index values, thickness and originating from a non-toughened source, the known clear glass from the jewellery box (item 1). The clear glass recovered from the suspect's backpack (item 3) did not match, with regard to refractive index values and thickness, the known clear glass from the jewellery box (item 1). The findings provide moderately strong support for the view that the glass from the suspect's car seat came from the jewellery box rather than from another source. The glass from the suspect's backpack did not come from the jewellery box. I have chosen the above phrase from the following scale: weak support, moderate support, moderately strong support, strong support, very strong support, extremely strong support.
JV7PJP	Known glass (Item 1), reportedly from the victim’s jewelry box, was examined and found to be consistent with the questioned glass (Item 2), reportedly from the suspect’s car seat with respect to color, thickness, density, gross elemental composition and refractive index. Based on these observations, it is the opinion of this analyst that the known glass (Item 1) and the questioned glass (Item 2) are of the same type and could have a common origin. This analyst recognizes that other sources of glass with properties consistent with the above glass exist. Known glass (Item 1), reportedly from the victim’s jewelry box, was examined and found to be inconsistent with the questioned glass (Item 3), reportedly from the suspect’s backpack, with respect to physical properties.
JWJGAK	The glass from Item 2 is similar in color, thickness, fluorescence, elemental composition, and refractive index to the glass from the standard, Item 1. The glass from Item 2 could have originated from Item 1 or any other broken glass source that is similar in color, thickness, fluorescence, elemental composition, and refractive index. The glass from Item 3 is similar in color and thickness but is not similar in fluorescence or elemental composition to the glass from the standard, Item 1. The glass from Item 3 did not originate from Item 1. Chemical analysis performed includes: Polarized Light Microscopy, X-Ray Fluorescence Spectroscopy and Glass Refractive Index Measurement (GRIM). Samples collected and analyzed during the examination of the items in this case (ex. slides) have been returned to and retained with the original item.
K99MWN	a. Laboratory items 1 through 3 were tested using a probe and examined visually and microscopically with the aid of a polarized light microscope, and were tested for solubility in water. i. Laboratory items 1 through 3 were found to be hard, isotropic, insoluble in water, and exhibited conchoidal fractures, which are characteristics of glass. ii. Laboratory items 1 through 3 were observed to have two parallel original surfaces. 2. Comparison a. Examination of Laboratory item 3 (Q2a and Q2b) and comparison to Laboratory 1 (K1a and K1b) disclosed that they are different with respect to their thickness and response to ultraviolet light. b.

TABLE 3

WebCode	Conclusions
	Examination of Laboratory item 2 (Q1a and Q1b) and comparison to Laboratory item 1 (K1a and K1b) disclosed that they are consistent and no discriminating differences were observed with respect to color, appearance, thickness, and response to UV light. c. In addition, instrumental analysis of Laboratory item 2 (Q1a) and comparison to Laboratory item 1 (K1a) disclosed that they are consistent and no discriminating differences were observed with respect to their elemental composition and refractive index. d. Q1b and K1b were not instrumentally analyzed and no further conclusions can be made regarding these particles. E) INTERPRETATION OF RESULTS 1. It is the opinion of the undersigned that Laboratory item 3 (Q2a and Q2b) could not have originated from the source represented by Laboratory item 1 (K1a and K1b). 2. It is the opinion of the undersigned that Laboratory item 2 (Q1a) could have originated from the same source as Laboratory item 1 (K1a) or another source exhibiting all of the same analyzed characteristics.
KFBP8F	Physical, microscopic, and instrumental examination and analysis of item 1, known glass, in conjunction with item 2, questioned glass, revealed them to be the same with respect to physical and optical properties and elemental composition. Therefore, item 2 came from the source represented by item 1 or another source of glass with identical physical and optical properties and elemental composition. Physical and microscopic examination and analysis of item 1, known glass, in conjunction with item 3, questioned glass, revealed them to be different with respect to physical and optical properties, Therefore, item 3 could not have come from the source represented by item 1.
L7CNXF	Items 1 and 2 cannot be discriminated by the methods used. The glass recovered from the suspect's car seat (item 2) can therefore have originated from the victim's jewelry box (item 1). The glass recovered from the suspect's backpack (item 3)is clearly different from the glass of the jewelry box (item 1)and cannot originate therefrom.
LL92EW	The glass (Item 001-02) recovered from the suspect’s car seat was indistinguishable in physical appearance, refractive index, and elemental composition from the glass (Item 001-01) taken from the jewelry box. Therefore, the glass recovered from the suspect’s car seat could have originated from the jewelry box or from another source of glass produced by the same glass manufacturer exhibiting the same physical and chemical properties. The glass (Item 001-03) recovered from the suspect’s backpack had a different refractive index than the glass (Item 001-01) recovered from the jewelry box; therefore, it did not come from the jewelry box.
LVYJUQ	In my opinion the findings provide moderately strong support for the proposition that the glass in Item 2 originated from Item 1, the jewellery box. The glass in Item 3 is different to Item 1 in physical properties and could not have originated from that source.
MF3L9L	Items 1, 2 and 3 were examined visually and using stereomicroscopy, an ultraviolet light, and a digital caliper. Items 1 and 2 were further examined using the Glass Refractive Index Measurement system (GRIM3). It should be noted that this examination did not include elemental analysis. The Item 2 glass particles were consistent with the Item 1 glass in color, type, temper, thickness, float properties, and refractive index. It was concluded that these Item 2 particles could have originated from the broken glass source represented by Item 1 or another source of broken glass with the same properties. The Item 3 glass particles could not be associated with the Item 1 glass due to differences in fluorescence and float properties.
MFGX3K	The glass in Item 2 was consistent with Item 1 and could have a common source. The glass in Item 3 was not consistent with the glass in Item 1.
MNT6NF	The glass from the suspect’s car seat in Item 2 either originated from the victim’s jewelry box represented by the known glass in Item 1 or from another source with the same optical, physical and elemental properties (Level III Association). The glass from the suspect’s backpack

TABLE 3

WebCode	Conclusions
	in Item 3 could not have originated from the victim's jewelry box represented by the known glass in Item 1 (Elimination).
MXX2NC	The chemical composition of all three samples was determined with LIBS and μXRF. The comparison of the chemical composition of the samples showed a good congruence between Item 1 and 2. Additonally, the density of the samples was determined. Item 1 and 2 have an identical density value. The density value of Item 3 differs clearly from the other value. Conclusion: Item 2 originates from the same object as Item 1
N38VZM	The known glass sample from the jewelry box (item 1) was found to consist of clear, colourless, float glass. The glass from the suspect's car seat (item 2) was also found to consist of clear, colourless, float glass. In relation to colour, thickness, refractive index and elemental composition the glass recovered from the suspect's car seat (item 2) was found to be indistinguishable to the known glass sample from the jewelry box (item 1). Therefore these two glass samples may share a common origin. The glass recovered from the suspect's backpack (item 3) was found to have a different thickness and refractive index to the known glass sample from the jewelry box (item 1) and therefore could not have originated from that source.
PFV4EF	Based on our analysis regarding the refractive index (GRIM) and the elemental composition (XRF) Item 2 could not be differentiated from Item 1. The questioned glass recovered from the suspect's car seat (Item 2) could therefore originate from the victim's jewelry box (Item 1). The questioned glass recovered from the suspects backpack (Item 3) could be clearly differentiated from the victim's jewelry box (Item 1). It originates from an unknown source.
PLYZ7R	1. Comparative examinations of Exhibit 1 (known glass taken from the victim's jewelry box) with Exhibit 2 (questioned glass recovered from the suspect's car seat) disclosed them to be consistent in physical characteristics, refractive indices, and elemental compositions. Therefore, Exhibit 2 could have originated from Exhibit 1, or another source with the exact same characteristics. 2. Comparative examinations of Exhibit 1 with Exhibit 3 (questioned glass recovered from the suspect's backpack) disclosed them to be inconsistent in physical characteristics and elemental compositions. Therefore, Exhibit 3 could not have originated from Exhibit 1. 3. It should be noted a glass association is not a means of positive identification and the number of possible sources for a specific glass is unknown.
PTLN4J	Based on the particles examined, the glass from Item #2 was consistent with Item #1 glass in the physical properties examined, refractive index, and inorganic composition. It was concluded that these particles could have originated from the same source or another source of broken glass with the same properties. Glass from Item #3 could not be associated with Item #1 glass due to differences in their thickness and refractive index.
PUPNV3	Item 2 may have the same source as item 1. Item 3 is definitely different from item 1.
Q4Z6BF	1. item #1 and item #2 could have been originated from the same source. 2. item #1 and item #3 could not have been originated from the same source.
Q8FX29	Glass recovered from the suspect's car seat (Item 2) is similar in color, thickness, fluorescence, and refractive index to the glass from the victim's jewelry box (Item 1). It is our opinion that the glass recovered from the suspect's car seat (Item 2) and the known glass from the victim's jewelry box (Item 1) could have come from the same source. Please note that our laboratory cannot currently perform elemental comparison and this could improve discrimination between glass samples. Glass recovered from the suspect's backpack (Item 3) is dissimilar in fluorescence to the glass from the victim's jewelry box (Item 1). It is our opinion that the glass from the suspect's backpack (Item 3) and the glass from the victim's jewelry box (Item 1) did not come from the same source.

TABLE 3

WebCode	Conclusions
Q9PP94	In my opinion, my findings provide moderately strong support for the proposition that the glass recovered from the suspect's car seat originated from the victim's jewelry box. In my opinion, my findings provide conclusive support for the proposition that the glass recovered from the suspect's back pack did not originate from the victim's jewelry box. The strength of the evidence or likelihood ratio in relation to either proposition considered is assessed on a scale of: no support for either proposition, limited, moderate, moderately strong, strong and very strong. Each point on the scale represents a numerical range, which has a logarithmic basis, such that each increment provides ten times greater support than the previous one.
QFULZG	Based on the particles examined, the glass from Item #2 was consistent with Item #1 glass in the physical properties examined, refractive index, and inorganic composition. It was concluded that these particles could have originated from the same source or another source of broken glass with the same properties. Glass recovered from Item #3 could not be associated with Item #1 glass due to differences in the physical properties examined, refractive index, and inorganic composition.
QNYQNR	The sample in Item 1 consists of two colorless glass fragments that exhibit characteristics consistent with non-tempered float 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 glass. Macroscopic, microscopic and instrumental examinations and comparisons of Items 1 and 2 revealed that they are like one another with respect to their color, thickness, refractive index values and chemical characteristics. It is therefore concluded that the glass fragments recovered from the car seat originated either from the victim's broken jewelry box or from another source of broken non-tempered float glass having these same characteristics. Item 3 consists of two colorless glass fragments that have their full thickness and exhibit characteristics consistent with non-tempered glass. While the glasses in Items 1 and 3 could not be discriminated by examinations of their color or thicknesses, significant differences between them were observed with respect to their fluorescence under ultraviolet lamps as well as their chemical compositions. Therefore, the glass from the subject's backpack could not have originated from the victim's broken jewelry box represented by Item 1.
RCH9M8	1. The particles of questioned glass recovered from the suspect's car seat (item 2) and the two fragments of known glass taken from the victim's jewelry box as represented by item 1 confirmed in their Refractive Indexes and in features of UV-Fluorescence. Accordingly, the glass recovered from the suspect's car seat (item 2) can originate from the glass from the victim's jewelry box (item 1) or from another source of the glass with the same features. 2. The particles of questioned glass recovered from the suspect's backpack (item 3) and the two fragments of known glass taken from the victim's jewelry box as represented by item 1 did not confirm in the Refractive Index. These glass particles recovered from the suspect's backpack did not originate from the victim's jewelry box (item 1).
RLQZYN	The glass recovered from the suspect's car seat (Item 2) is similar in color, thickness, fluorescence, elemental composition and refractive index in comparison to the glass taken from the victim's jewelry box (Item 1). The glass from Item 2 could have originated from Item 1 or any other broken glass source that is similar in color, thickness, fluorescence, elemental composition and refractive index. The glass recovered from the suspect's backpack (Item 3) is similar in color and thickness, but is not similar in fluorescence, elemental composition and refractive index in comparison to the glass taken from the victim's jewelry box (Item 1). The glass from Item 3 could not have originated from Item 1.
TFKLRC	The two particles of questioned glass, recovered from the suspect's car seat (Item 2) are similar in elemental composition compared with the known glass Item 1). These results are much more

TABLE 3

WebCode	Conclusions
	likely if the questioned particles (item 2) have originated from the glass taken from the victim's jewelry box, represented by the particles from (Item 1), than if they have originated from a random other glass object. The two particles of questioned glass, recovered from the suspect's backpack (Item 3) differ in elemental composition from the known glass (Item 1). Therefore these particles (Item 3) could not have originated from the victim's jewelry box, represented by the particles from (Item 1).
TMXKDB	The evidence (elemental composition of glass samples as well as the thickness measurements) provides support for the proposition that glass fragments recovered from suspect's car seat (Item 2) could have originated from the victim's jewellery box (Item 1) whereas glass fragments recovered from suspect's backpack (Item 3) have not originated from the victim's jewellery box (Item 1).
TNWPU6	The known glass sample from the jewelry box (item 1) and from the suspect's backpack (item 3) could be well distinguished by the manufacturing process (float / non float), by the refractive index and by the elemental composition. The two glass particles from the suspect's car seat (item 2) matched the known glass sample from the jewelry box (item 1) with respect to color, thickness, refractive index before and after an annealing procedure and chemical composition. Hence there is serious evidence that these two particles come from the broken jewelry box at the scene of crime. Due to the mass product character of glass products a different source cannot be excluded with certainty. Among a casework database, which consists of about 3300 control glass items, there was no item, which matched the glass particles from the suspect's car seat with respect to the mentioned properties.
U2EYUF	Conclusion: Glass recovered from the suspect's car seat (Item #2) compares by physical, optical and elemental properties to glass collected from the victim's jewelry box (Item #1). This indicates that they could have had a common origin or could have originated from another glass source with indistinguishable properties. Glass recovered from the suspect's backpack (Item #3) does not compare by physical, optical and elemental properties to glass collected from the victim's jewelry box (Item #1). This indicates that they could not have had a common origin.
U9VB8F	Item 2 is consistent with Item 1. Item 3 is not consistent with Item 1.
UELKJZ	(1) The questined glass recovered from the suspect's car seat (Item 2) had similar physical characteristics to the known glass from the victim's jewelry box (Item 1) and could have had a common origin. (2) The questioned glass recovered from the suspect's backpack (Item 3) did not have a common origin with the glass from the victim's jewelry box (Item 1).
URCGLX	In my opinion, the findings provide moderately strong support for the proposition that the piece of glass recovered from the car seat came from the broken pane sampled from the jewelry box, rather than from some other, random and unrelated source of glass.
V4WEZ2	As a result of my examination I determined that: 3.1 The chemical composition of exhibit Item 1 is indistinguishable from the chemical composition of exhibit Item 2 therefore they could have the same origin. 3.2 The chemical composition of exhibit Item 1 is distinguishable from the chemical composition of exhibit Item 3 therefore they could not have the same origin.
VBMMT8	The following methodologies were used in the examination of this case: visual examination, physical examination, microscopy, digital calipers, UV fluorescence, XRF and GRIM3. Examination showed the glass in Item #2 is consistent in physical properties, refractive index, and elemental composition with the glass in Item #1. These fragments could have shared a common origin. Item #3 and Item #1 were not consistent in physical properties and elemental composition. These items could not have shared a common origin.

TABLE 3

WebCode	Conclusions
VFD4Y7	On analysis, I found: i. The refractive index of the questioned glass recovered from the suspect's car seat (ITEM 2) and the refractive index of the known glass taken from the victim's jewelery box (ITEM 1) to be similar. ii.The refractive index of the questioned glass recovered from the suspect's backpack (ITEM 3) to be different with the refractive index of the known glass taken from the victim's jewelery box (ITEM 1). Therefore, I am of the opinion that: i. The questioned glass recovered from the suspect's car seat (ITEM 2) and the known glass taken from the victim's jewelery box (ITEM 1) could have come from the same source. ii.The questioned glass recovered from the suspect's backpack (ITEM 3) did not come from the same source as the known glass taken from the victim's jewelery box (ITEM 1).
VU9KN4	The two particles of questioned glass recovered from the suspect's car seat (Item 2), the two particles of questioned glass recovered from the suspect's backpack (Item 3) and the two fragments of known glass taken from the victim's jewelry box (Item 1) were examined visually using stereomicroscopy and a digital caliper. These Items 1, 2 and 3 were further examined using the Glass Refractive Index Measurement system (GRIM 3). Based on the fragments examined, the Item 1 glass fragments were consistent with the Item 2 glass in color, thickness and refractive index. It was concluded that these Item 2 glass could have originated from the glass source represented by Item 1. The Item 1 glass fragments were found to be different from Item 3 glass due to differences in refractive index.
WEDKCV	In my opinion, the findings provide strong support for the proposition that the glass from the car seat of the suspect (item 2) originated from the same source as the jewellery box (item 1)rather than not. In my opinion, the findings show conclusively that the glass from the backpack of the suspect (item 3) did not originate from the same source as the jewellery box (item 1).
WHX89P	The chemical composition of Item 2 is indistinguishable with the chemical composition of Item 1, therefore the glass could have the same origin. The chemical composition of Item 3 is distinguishable with the chemical composition of Item 1, therefore the glass could not have the same origin.
WVZXQM	Glass recovered from the debris from the suspect's car seat (Item 2) is indistinguishable in the observed and measured physical properties, refractive index, and elemental composition from the glass from the victim's jewelry box (Item 1). Therefore, the glass recovered from the debris from the suspect's car seat (Item 2) either originated from the victim's jewelry box as represented by Item 1, or from another source of broken glass indistinguishable in all the observed and measured physical properties, refractive index, and elemental composition. Glass recovered from the debris from the suspect's backpack (Item 3) is different than the glass sample from the victim's jewelry box (Item 1). Accordingly, the victim's jewelry box as represented by Item 1 is eliminated as a possible source of the glass recovered from the debris from the suspect's backpack (Item 3).
WYG7C2	The glass recovered from the suspect's car seat Item2, was indistinguishable in physical properties, refractive index and elemental composition to the glass taken from the victim's jewelry box Item1, therefore, The glass recovered from the suspect's car seat Item2, could have originated from the glass taken from victim's jewelry box Item1 or from another source of glass produced by the same manufacturer exhibiting the same physical and chemical properties. The glass recovered from the suspect's backpack Item3, could not have originated from the glass taken from the victim's jewelry box Item1.
XHCB28	CTS Item 1 consists of two broken glass fragments. CTS Item 2 consists of two broken glass fragments. CTS Item 3 consists of two broken glass fragments. The glass recovered from CTS Items 1 and 2 each include glass fragments which are similar in physical and optical properties. The CTS Item 2 glass particles either originated from the known glass source represented by

TABLE 3

WebCode	Conclusions
	CTS Item 1 or from another broken glass source with similar properties. Questioned glass particles recovered from CTS Item 3 could not have originated from the known glass source represented by CTS Item 1 due to differences in physical and optical properties. CTS Items 1, 2, and 3 were analyzed using stereomicroscopy, polarized light microscopy, an alternate light source, a micrometer, and a refractive index apparatus consisting of a phase contrast microscope with a variable temperature stage and a monochromator.
XWEHGC	The questioned glass fragments from the suspect's car seat (Item 2) were determined to be glass which are similar in color, thickness, fluorescence, and refractive index to the known glass from the victim's jewelry box (Item 1). Trace elemental comparison between this item and the known glass from the victim's jewelry box (Item 1) cannot be performed by our laboratory at this time. It is our opinion that this item could have come from the known glass from the victim's jewelry box or any other source of broken glass with similar characteristics. (Category 2C) The questioned glass fragments from the suspect's backpack (Item 3) were determined to be glass which are dissimilar in refractive index to the known glass from the victim's jewelry box (Item 1). It is our opinion that this item did not come from the known glass from the victim's jewelry box (Item 1). (Category 5)
Y7WNKT	1). The particles of questioned glass recovered from the suspect´s car seat (Item 2) could not be excluded as having come from the victim´s jewelry box (Item 1). Therefore, these glass particles came from either the victim´s jewelry box or from another source or sources of broken, clear float glass indistinguishable from item 1 in thickness and refractive index. 2). The recovered fragments from suspect´s backpack (Item 3) were found to be distinguishable from the known glass taken from the victim´s jewelry box (Item 1). This negative comparison indicates a different origin between both items.
Y83BXX	The questioned glass particles in Item 2 did not originate from the victim's jewelry box as presented by Item 1. The questioned glass particles in Item 3 did not originate from the victim's jewelry box as presented by Item 1.
Z2WYE7	Based on analysis of triplicate 2-4 mg portions, Item 2 could not be distinguished from Item 1 on the basis of the concentration of 49 elements. Therefore, Item 2 could have come from the same source as Item 1. Based on analysis of triplicate 2-4 mg portions, Item 3 could be distinguished from Item 1 on the basis of the concentration of 9 of 49 elements (V, Mn, Fe, Co, Ga, Rb, Cs, Ba, & La). Therefore, Item 3 could not have come from the same source as Item 1. For comparative purposes, samples were considered distinguishable if the smaller of the U95 or 4s ranges do not overlap.
ZE6HC2	Based on the elemental composition and thickness of the samples, Item 2 was considered to have originated from the victim's jewellery box Item 1.

Additional Comments

TABLE 4

WebCode	Additional Comments
2K2WB8	Statistical treatment: On the one hand, t-test for thickness and refraction index. On the other hand, 4SD (previous minimun 3% RSD filtered) for LA-ICP-MS results.
48RT9A	My conclusions are based on the results of my laboratory examination and the information made available to me at this time. If any aspects of the case should change then I am prepared to review my conclusion in light of such changes.
4KE6ER	Glass particles found on the suspect's car seat could have originated from the glass from the victim's jewelry box.
6BQN84	The number of known glass fragments (item 1) supplied is not adequate to represent a known source of glass, and not adequate to fully comply with ASTM standard for forensic glass comparison. Information about the design of the jewelry box (reported source of item 1) is required to determine whether or not similarities and differences in thickness measurements of the various items are significant.
6KTV33	Examination of questioned glass fragment Q2 (from lab item #2) and comparison to known glass fragments K1 & K2 (lab item #1) disclosed that they are consistent and no discriminating differences were observed with respect to color, appearance, thickness, response to UV light and elemental composition. However, no further analysis was performed on Q2 therefore no conclusion could be reached.
8A7RR9	The glass in Items 1 and 2, are similar in color, type of glass, thickness, fluorescence, density and refractive index. The glass in Items 1 and 3, are dissimilar in fluorescence, density and refractive index.
BQ4V4A	Additional information provided in the report includes descriptions of methods, guidance on interpretation of results, explanations of the limitations of the examinations, and remarks regarding sample disposition and data storage. This information has be omitted from the Conclusions above to comply with CTS requirements.
C3T8WY	Of the 2319 samples of broken glass from casework and survey samples from the [Location], examined at the [laboratory] for which refractive index, thermal history, thickness and float data are available, 7 (0.3%) are annealed, float glass, indistinguishable from item 1 in refractive index and thickness. A study performed at the [laboratory] examining 150 casework samples of architectural and vehicle float glass by LA-ICP-MS resulted in 11,175 pair-wise comparisons. Of these pairs, 6 (0.06%) were indistinguishable in elemental composition, using the 22 elements examined in this case. It should be noted that 4 of these 6 pairs were differentiated by refractive index, and the remaining 2 pairs were differentiated by thickness. (NB: I understand that you may strip out the information that identifies this lab).
EMPQGN	The refractive indices for Item 1 to Item 3 were found to be: Item 1: 1.5222 – 1.5223, Item 2: 1.5222 – 1.5223, Item 3: 1.5156 – 1.5157. Item 1 to Item 3 were found to consist of two pieces of clear and colourless glass fragments. The questioned glass marked “Item 3” was found to be different from the control glass marked “Item 1” in terms of fluorescence, thickness, refractive index and trace elemental composition. The questioned glass marked “Item 2” was found to have no significant differences when compared with the control glass marked “Item 1” in terms of colour, fluorescence, thickness, refractive index and trace elemental composition. Elemental compositions: The match criterion for LA-ICP-MS analysis was set as 4SD range (min 3%RSD) around control sample.
FLP4LV	Short and long wavelength fluorescence was used to describe each of the items however, due to the weakness of any fluorescence observed it was not used as a comparative element in this examination.

TABLE 4

WebCode	Additional Comments
JE2H6M	There is insufficient information on the size of the jewellery box to assess potential transfer of glass.
MXX2NC	Chemical composition: LIBS (Elemental oxide in wt.-%) Al2O3 CaO Fe2O3 K2O MgO Na2O Item 1 0.26 10.41 0.073 0.19 1.60 13.93 Item 2 0.27 10.55 0.075 0.25 1.73 14.08 Item 3 1.67 7.00 0.184 0.62 4.22 14.41 μXRF (Elemental oxide in wt.-%) Na2O SiO2 CaO Al2O3 MgO SO3 TiO2 Fe2O3 K2O Item 1 14.31 72.41 11.32 0.31 1.23 0.19 0.03 0.09 0.08 Item 2 14.25 72.55 11.37 0.28 1.17 0.16 0.03 0.10 0.09 Item 3 13.65 72.88 7.10 1.48 4.22 0.67 0.04 0.19 0.53 Density: Item 1 2.5067 g/cm3 Item 2 2.5067 g/cm3 Item 3 2.4805 g/cm3 [Participant submitted data in a format that could not be reproduced in this report].
Q4Z6BF	Thickness: Item#1 1.91 mm, Item#2 1.91 mm, item #3 1.96mm. UV fluorescence at deep UV: items #1 & 2 strong, item#3 weak. RI (range): Item#1: 1.52209-1.52218, Item#2: 1.52207-152221, Item#3: 151550-151565. SEM-EDX: Item#1 and item#2 contained: Si,O, Na,Ca and minorities of Mo,Cr,K,P,Al.Mg,Fe
RLQZYN	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.
TMXKDB	The answer is based on results of likelihood ration calculations (elemental composition of glass).
TNWPU6	The following match criteria were applied: Refractive index: Ten measurements were made at each sample. Then a Student-t-test was conducted where p-values above 1 percent would be assessed as a match. Elemental composition: Ten measurements were made at the original (antifloat-) surface of each sample. Semiquantitative analysis was performed for elemental ratios Ca/Mg, Ca/K, Ca/Ti and Ca/Fe calculated from the net intensities. A match was stated if the mean of the questioned sample matched the mean of the known sample plus/minus the threefold standard deviation of the known sample.
U9VB8F	It is necessary to do elemental analysis for Item 1 and 2. This lab cannot perform this analysis at the moment.
WVZXQM	A report of examination issued with these conclusion would also contain information about the methods used, interpretation guidance and limitations of the examination.
XWEHGC	Trace elemental comparison could not be performed by our laboratory at this time due to XRF being currently out of service.
Y7WNKT	The refractive index was measured with a Glass Refractive Index Measurement 3 (GRIM3, Foster and Freeman) system.

-End of Report-
(Appendix may follow)

Appendix: Data Sheet

*****

Collaborative Testing Services ~ Forensic Testing Program

Test No. 18-548: Glass Analysis

DATA MUST BE RECEIVED BY ***August 06, 2018*** TO BE INCLUDED IN THE REPORT

Participant Code: WebCode:

Accreditation Release Statement

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

☐ This participant's data is intended for submission to ASCLD/LAB, ANAB, and/or A2LA.
(Accreditation Release section on the last page must be completed and submitted.)

☐ This participant's data is NOT intended for submission to ASCLD/LAB, ANAB or A2LA.

Scenario:

Police are investigating the burglary of a home in which jewelry was stolen. A known sample was taken from the broken glass remaining in the jewelry box. Several days later, police apprehended a suspect that was in commission of a similar burglary in the same neighborhood. Police conducted a search of the suspect and his vehicle. Particles of glass were found on the suspect's car seat and in his backpack. Investigators are requesting that you examine and compare the glass particles recovered from the car seat and backpack with the fragments recovered from the victim's jewelry box.

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: Two fragments of known glass taken from the victim's jewelry box.

Item 2: Two particles of questioned glass recovered from the suspect's car seat.

Item 3: Two particles of questioned glass recovered from the suspect's backpack.

1.) Could the questioned glass particles in Items 2 and/or 3 have originated from the victim's jewelry box as represented by Item 1?

Item 2:	Yes ☐		No ☐		Inconclusive ☐
Item 3:	Yes ☐		No ☐		Inconclusive ☐

Please return all pages of this data sheet.

Printed: August 16, 2018

Participant Code:
WebCode:

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

Refractive Index:

☐ nD ☐ nC

☐ nF ☐ Δ RI

UV Fluorescence:

☐ Long

☐ Short

☐ Color ☐ Thickness

☐ Density

Elemental Analysis:

☐ SEM/EDS ☐ XRS/XRF

☐ Other *(specify)*: _____

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

4.) Additional Comments

Return Instructions: Data must be received via online data entry, fax (please include a cover sheet), or mail by ***August 06, 2018*** to be included in the report. Emailed data sheets are not accepted.

QUESTIONS?
TEL: +1-571-434-1925 (8 am - 4:30 pm EST)
EMAIL: forensics@cts-interlab.com
www.ctsforensics.com

Participant Code:

ONLINE DATA ENTRY: www.cts-portal.com

FAX: +1-571-434-1937

MAIL: Collaborative Testing Services, Inc.
P.O. Box 650820
Sterling, VA 20165-0820 USA

Please return all pages of this data sheet.

Printed: August 16, 2018

Collaborative Testing Services ~ Forensic Testing Program

RELEASE OF DATA TO ACCREDITATION BODIES

The following Accreditation Releases will apply only to:

Participant Code: WebCode:

for Test No. **18-548: Glass Analysis**

This release page must be completed and received by ***August 6, 2018*** to have this participant's submitted data included in the reports forwarded to the respective Accreditation Bodies.

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. _____
(Include ASCLD/LAB Certificate here)

A2LA Certificate No. _____

Step 2: Complete the Laboratory Identifying Information in its entirety

Signature and Title _____

Laboratory Name _____

Location (City/State) _____

Accreditation Release

Return Instructions

Please submit the completed Accreditation Release at the same time as your full data sheet. See Data Sheet Return Instructions on the previous page.

Questions? Contact us 8 am-4:30 pm EST
Telephone: +1-571-434-1925
email: forensics@cts-interlab.com

Please return all pages of this data sheet.

Printed: August 16, 2018