



## **Shooting Reconstruction - Angle Determination Test No. 22-5620 Summary Report**

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Each sample set contained a wooden box that consisted of one entrance hole, one exit hole, and a "TOP" label to distinguish the orientation of the box. In addition, one "A" label and one "1" label was placed on opposing sides of the box to assist participants when reporting the entrance/exit holes and direction of travel. Participants were requested to determine the alphanumeric character associated with the entrance hole, the direction of travel, and calculate the angles. Data were returned from 105 participants and are 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**

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Each sample set contained a wooden box that consisted of one entrance hole, one exit hole, and a "TOP" label to distinguish the orientation of the box. In addition, one "A" label and one "1" label were placed on opposite sides of the box to assist participants when reporting the entrance/exit holes and direction of travel. Participants were requested to determine the entrance hole, the direction of travel and calculate the angles. The front of the box containing the "1" label was associated with the entrance hole and the direction of travel was right to left, downward. The angles as measured during production are described below.

PRODUCTION: The sample was placed onto a fixed angle set up (jig). A 9mm CZ Scorpion EVO firearm was affixed above the jig and a digital angle finder was placed on the jig to confirm the angle to be shot.

The Horizontal (Azimuth) angle was measured at  $16^{\circ}$  from perpendicular,  $106^{\circ}$  left to right or  $74^{\circ}$  right to left. The Vertical angle was measured downward at  $42^{\circ}$  or  $48^{\circ}$  upward.

VERIFICATION: Two of the three predistribution laboratories reported Horizontal and Vertical angles within  $\pm 5^{\circ}$  from the expected responses. The last predistribution laboratory did not report angle measurements due to their laboratory policy.

## Summary Comments

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This test was designed to allow participants to assess their proficiency in shooting reconstruction, with a focus on angle determination. Each sample set consisted of a wooden box (Item 1) containing an entrance and exit hole. The wooden box was designated with a "TOP" label to assist participants with the orientation of the sample. In addition, one "A" label and one "1" label were placed on opposite sides of the box to assist participants when reporting the entrance/exit holes and direction of travel. (Refer to Manufacturer's Information for preparation details.)

**ENTRANCE HOLE:** Of the 105 responding participants, 104 (99%) identified the side labeled "1" as containing the entrance hole.

**DIRECTIONALITY:** Of the 105 responding participants, 103 (98%) reported a right to left direction and two participants reported a left to right direction. In regard to upward/downward directionality, all 105 participants reported a downward direction.

### ANGLE DETERMINATION:

**HORIZONTAL:** Any reported horizontal angles that fell outside ranges  $11^{\circ}$  to  $21^{\circ}$  (from perpendicular),  $69^{\circ}$  to  $79^{\circ}$  (right to left), or  $101^{\circ}$  to  $111^{\circ}$  (left to right) were boxed as inconsistent. Of the 97 participants that reported horizontal angles, 91 (94%) reported angles that fell within the acceptable ranges. Of those, 69 (71%) reported angles ranging from  $69^{\circ}$  to  $79^{\circ}$  (right to left), 15 (15%) reported angles ranging from  $11^{\circ}$  to  $21^{\circ}$  (perpendicular), and 6 (0.6%) reported angles ranging from  $101^{\circ}$  to  $111^{\circ}$  (left to right). One participant fell outside of the  $69^{\circ}$  to  $79^{\circ}$  range but was not marked as an outlier due to their laboratory's included uncertainty and six participants reported angles that did not fall within  $\pm 5^{\circ}$  from the expected response and were marked as an outlier.

**VERTICAL:** Any reported vertical angles that fell outside ranges  $37^{\circ}$  to  $47^{\circ}$  or  $43^{\circ}$  to  $53^{\circ}$  (downward) were boxed as inconsistent. Of the 96 participants that reported vertical angles, 92 (96%) reported angles ranging from  $37^{\circ}$  to  $47^{\circ}$  or  $43^{\circ}$  to  $53^{\circ}$  (downward). Four participants reported angles that did not fall within  $\pm 5^{\circ}$  from the expected response and were marked as an outlier.

Currently, reported angles are reviewed using the uncertainty factor of  $\pm 5^{\circ}$  as well as the participant's reported uncertainty.

Eight participants did not report any angles. Of those, one participant only reported the horizontal/azimuth angle. CTS is aware that some labs will only report directionality and will not report any angle measurements.

## Entrance Hole

Which label on the box represents the entrance hole?

TABLE 1

<b>WebCode</b>	<b>Character</b>	<b>WebCode</b>	<b>Character</b>
22KQQB	1	8X4CPW	1
23EE97	1	8YWCKM	1
24R7Y2	1	9B9UZW	1
2HBT8E	1	9F3RM3	1
2NGCNR	1	9W7KU3	1
3KFJB9	1	B2RZUT	1
47A6A3	1	BHKQX3	1
4FFU87	1	BUCGCE	1
676RHY	1	C7M7RV	1
6BF6ZX	1	C9P8RT	1
6CATEM	1	CEDUKD	1
6CCHMQ	1	CFQG3R	1
6D776L	1	CG8H7U	1
6PFYGY	1	CTWGTP	1
6PJLU7	1	CXPG97	1
6RQL9L	1	CZW2VL	1
6ZH2XP	1	D3HZNA	1
7BBZ3Z	1	D4PFW2	1
7BDPB4	1	DDYPPZ	1
7F8R9C	1	DF6CVD	1
7KM2JV	1	DGYZHE	1
7PXAN7	1	DHVPF4	1
8DGRNM	1	DL9E3Y	1

WebCode	Character	WebCode	Character
DMP96U	1	MR8PC3	1
DQZHTH	1	MUTPBJ	1
DTU6TZ	1	MVLP79	1
DUNUU9	1	N6RR8Z	1
EKDT98	1	N7LDZQ	1
EQHRKX	1	NG33WB	1
ETKRFN	1	NNJVNZ	1
F38BC9	1	P3U2C6	1
F3RV3D	1	PF69EW	1
F7B2MU	1	PGYWV8	1
FUFRYK	1	PTRNC6	1
G8FVXK	1	Q23Y93	1
GD4DDG	1	Q3RB42	1
GW2QVU	1	Q3VXG9	1
H29MAN	1	Q3ZB9C	1
HLHJRY	1	RN96BY	1
HNKHZ7	1	RYRKE2	1
HUCRA6	1	T6DWQ9	A
JRD2GV	1	VB8XN6	1
KKC9L7	1	VRWTFV	1
KVWFJB	1	W9KLH8	1
LB27Z7	1	WBBKZC	1
LCYGW9	1	WLN3CF	1
LKV8LP	1	WM2EC7	1
MFRXNT	1	WVK78	1

WebCode	Character	WebCode	Character
WZ9HFF	1		
XCZD9Z	1		
XE476K	1		
XMXCXL	1		
XNR2ZU	1		
YG8C26	1		
ZMNCT3	1		
ZY3FVR	1		
ZZV6HT	1		

<b>Response Summary</b>			Participants: <b>105</b>
Which label on the box represents the entrance hole?			
<b>Character:</b>	A		1
<b>Total:</b>	1		104
<b>Percent:</b>	1.0%		99.0%

## Direction of Travel

What is the direction of travel of the bullet through the box? (check all that apply)

TABLE 2

WebCode	Left / Right	Upward / Downward
22KQQB	Right to Left	Downward
23EE97	Right to Left	Downward
24R7Y2	Right to Left	Downward
2HBT8E	Right to Left	Downward
2NGCNR	Right to Left	Downward
3KFJB9	Left to Right	Downward
47A6A3	Right to Left	Downward
4FFU87	Right to Left	Downward
676RHY	Right to Left	Downward
6BF6ZX	Right to Left	Downward
6CATEM	Right to Left	Downward
6CCHMQ	Right to Left	Downward
6D776L	Right to Left	Downward
6PFYGY	Right to Left	Downward
6PJLU7	Right to Left	Downward
6RQL9L	Right to Left	Downward
6ZH2XP	Right to Left	Downward
7BBZ3Z	Right to Left	Downward
7BDPB4	Right to Left	Downward
7F8R9C	Right to Left	Downward
7KM2JV	Right to Left	Downward
7PXAN7	Right to Left	Downward
8DGRNM	Right to Left	Downward
8X4CPW	Right to Left	Downward
8YWCKM	Right to Left	Downward
9B9UZW	Right to Left	Downward
9F3RM3	Right to Left	Downward
9W7KU3	Right to Left	Downward
B2RZUT	Right to Left	Downward

TABLE 2

<b>WebCode</b>	<b>Left / Right</b>	<b>Upward / Downward</b>
BHKQX3	Right to Left	Downward
BUCGCE	Right to Left	Downward
C7M7RV	Right to Left	Downward
C9P8RT	Right to Left	Downward
CEDUKD	Right to Left	Downward
CFQG3R	Right to Left	Downward
CG8H7U	Right to Left	Downward
CTWGTP	Right to Left	Downward
CXPG97	Right to Left	Downward
CZW2VL	Right to Left	Downward
D3HZNA	Right to Left	Downward
D4PFW2	Right to Left	Downward
DDYPPZ	Right to Left	Downward
DF6CVD	Right to Left	Downward
DGYZHE	Right to Left	Downward
DHVBF4	Right to Left	Downward
DL9E3Y	Right to Left	Downward
DMP96U	Right to Left	Downward
DQZHTH	Right to Left	Downward
DTU6TZ	Right to Left	Downward
DUNUU9	Right to Left	Downward
EKDT98	Right to Left	Downward
EQHRKX	Right to Left	Downward
ETKRFN	Right to Left	Downward
F38BC9	Right to Left	Downward
F3RV3D	Right to Left	Downward
F7B2MU	Right to Left	Downward
FUFRYK	Right to Left	Downward
G8FVXK	Right to Left	Downward
GD4DDG	Right to Left	Downward
GW2QVU	Right to Left	Downward



TABLE 2

<b>WebCode</b>	<b>Left / Right</b>	<b>Upward / Downward</b>
H29MAN	Right to Left	Downward
HLHJRY	Right to Left	Downward
HNKHZ7	Right to Left	Downward
HUCRA6	Right to Left	Downward
JRD2GV	Right to Left	Downward
KKC9L7	Right to Left	Downward
KVWFJB	Right to Left	Downward
LB27Z7	Right to Left	Downward
LCYGW9	Right to Left	Downward
LKV8LP	Right to Left	Downward
MFRXNT	Right to Left	Downward
MR8PC3	Right to Left	Downward
MUTPBJ	Right to Left	Downward
MVLP79	Right to Left	Downward
N6RR8Z	Right to Left	Downward
N7LDZQ	Right to Left	Downward
NG33WB	Right to Left	Downward
NNJVNZ	Right to Left	Downward
P3U2C6	Right to Left	Downward
PF69EW	Right to Left	Downward
PGYWV8	Right to Left	Downward
PTRNC6	Right to Left	Downward
Q23Y93	Right to Left	Downward
Q3RB42	Right to Left	Downward
Q3VXG9	Right to Left	Downward
Q3ZB9C	Right to Left	Downward
RN96BY	Right to Left	Downward
RYRKE2	Right to Left	Downward
T6DWQ9	Right to Left	Downward
VB8XN6	Right to Left	Downward
VRWTFV	Right to Left	Downward

TABLE 2

WebCode	Left / Right	Upward / Downward
W9KLH8	Right to Left	Downward
WBBKZC	Right to Left	Downward
WLN3CF	Right to Left	Downward
WM2EC7	Right to Left	Downward
WVVK78	Right to Left	Downward
WZ9HFF	Right to Left	Downward
XCZD9Z	Right to Left	Downward
XE476K	Right to Left	Downward
XMXCXL	Right to Left	Downward
XNR2ZU	Left to Right	Downward
YG8C26	Right to Left	Downward
ZMNCT3	Right to Left	Downward
ZY3FVR	Right to Left	Downward
ZZV6HT	Right to Left	Downward

<b>Response Summary</b>				<b>Participants: 105</b>		
What is the direction of travel of the bullet through the box?						
<i>Direction:</i>	Right to Left	Left to Right	No Response	Upward	Downward	No Response
<b>Total:</b>	103	2	0	0	105	0
<b>Percent:</b>	98.10%	1.9%	0.00%	0.0%	100.0%	0%

# Angles

TABLE 3 - Horizontal (Azimuth)

WebCode	Angle Measurement	Uncertainty (in degrees)
22KQQB	73 horizontal/17 azimuth	5
23EE97	71	5
24R7Y2	17.8	2.5
2HBT8E	72	5
2NGCNR	17	
3KFJB9	75	3
47A6A3	71	5
4FFU87	70	5
676RHY	42.5	5
6BF6ZX	20	5
6CATEM	17.66	
6CCHMQ	71	2
6D776L	104 L-R	5
6PFYGY	74	
6PJLU7	70	5
6RQL9L		
6ZH2XP	71.9	2.6
7BBZ3Z	69	
7BDPB4	71	
7F8R9C	16 from perpendicular	5
7KM2JV	102	
7PXAN7	73	5
8DGRNM	17	
8X4CPW	18 from perpendicular	
8YWCKM	73.5	5
9B9UZW	72	5
9F3RM3	70	5

TABLE 3 - Horizontal (Azimuth)

WebCode	Angle Measurement	Uncertainty (in degrees)
9W7KU3	76	5
B2RZUT	75 degrees	
BHKQX3	29 (NATO)	5
BUCGCE		
C7M7RV	71	5
C9P8RT	70.5	5
CEDUKD	72	5
CFQG3R	71	
CG8H7U	77	5
CTWGTP	77.3	5
CXPG97	71	5
CZW2VL		
D3HZNA	73	5
D4PFW2	20	
DDYPPZ	19	7
DF6CVD	42	2
DGYZHE	72.0	2.6
DHVPF4	44	0
DL9E3Y	79	
DMP96U	72	5
DQZHTH	72	5
DTU6TZ	72	
DUNUU9	72	5
EKDT98	71	5
EQHRKX	72	
ETKRFN	73	5
F38BC9	70	5
F3RV3D	68	
F7B2MU	107	

TABLE 3 - Horizontal (Azimuth)

WebCode	Angle Measurement	Uncertainty (in degrees)
FUFYK	75	5
G8FVXK	103	5
GD4DDG		
GW2QVU	71	5
H29MAN	73°	72°-74°
HLHJRY	19	
HNKHZ7	76	5
HUCRA6	70	5
JRD2GV	103-90=13	5
KKC9L7	76	5
KVWFJB	75	5
LB27Z7	17	5
LCYGW9	72.7	2.6
LKV8LP	70.5	
MFRXNT	72	5
MR8PC3	74	5
MUTPBJ	74	2
MVLP79		
N6RR8Z	72	5
N7LDZQ	73	5
NG33WB		
NNJVNZ	74	5
P3U2C6	72 degrees Right to Left	3
PF69EW	74	5
PGYWW8		
PTRNC6	73	
Q23Y93	70.7	2.6
Q3RB42	72	5
Q3VXG9	71	3

TABLE 3 - Horizontal (Azimuth)

WebCode	Angle Measurement	Uncertainty (in degrees)
Q3ZB9C	71	5
RN96BY	18	5
RYRKE2	71.8	2.6
T6DWQ9	79.92	5
VB8XN6	70	5
VRWTFV	72	5
W9KLH8	75 degrees	
WBBKZC	72	5
WLN3CF	73	
WM2EC7	72 (from surface)	5
WVK78	74	1
WZ9HFF	71	5
XCZD9Z		
XE476K	20	5
XMXCXL	18.7	2
XNR2ZU	48°	
YG8C26	106	5
ZMNCT3	69	5
ZY3FVR	104	5
ZZV6HT	72.5	2.6

TABLE 3 - Vertical

WebCode	Angle Measurement	Uncertainty (in degrees)
22KQQB	44	5
23EE97	46	5
24R7Y2	47.3	2.5
2HBT8E	45	5
2NGCNR	45	
3KFJB9	45	3
47A6A3	-45.5	5
4FFU87	43	5
676RHY	74.2	5
6BF6ZX	45	5
6CATEM	41.71	
6CCHMQ	45	2
6D776L	43 down	5
6PFYGY	-41	
6PJLU7	46	5
6RQL9L		
6ZH2XP	45.1	2.6
7BBZ3Z	47	
7BDPB4	47	
7F8R9C	-43	5
7KM2JV	42	
7PXAN7	42	5
8DGRNM	43	
8X4CPW	42	
8YWCKM	44	5
9B9UZW	44	5
9F3RM3	46	5
9W7KU3	47	5
B2RZUT	44 degrees	

TABLE 3 - Vertical

WebCode	Angle Measurement	Uncertainty (in degrees)
BHKQX3	43.5 downward	5
BUCGCE		
C7M7RV	44	5
C9P8RT	48	5
CEDUKD	-46	5
CFQG3R	49	
CG8H7U	45	5
CTWGTP	40.2	5
CXPG97	43	5
CZW2VL		
D3HZNA	-43	5
D4PFW2	47	
DDYPPZ	43	7
DF6CVD	15	2
DGYZHE	46.5	2.6
DHVBF4	15	0
DL9E3Y	43	
DMP96U	44	5
DQZHTH	-43	5
DTU6TZ	-44	
DUNUU9	-43	5
EKDT98	-44	5
EQHRKX	43	
ETKRFN	43	5
F38BC9	-43.8	5
F3RV3D	46	
F7B2MU	46	
FUFYK	43	5
G8FVXK	43	5



TABLE 3 - Vertical

WebCode	Angle Measurement	Uncertainty (in degrees)
GD4DDG		
GW2QVU	-44	5
H29MAN	47°	46°-48°
HLHJRY	45	
HNKHZ7	-42	5
HUCRA6	-41	5
JRD2GV	43	5
KKC9L7	42	5
KVWFJB	135	5
LB27Z7	42	5
LCYGW9	42.0	2.6
LKV8LP	42.2	
MFRXNT	45	5
MR8PC3	-45	5
MUTPBJ	43	2
MVLP79		
N6RR8Z	43	5
N7LDZQ	41	5
NG33WB		
NNJVNZ	45	5
P3U2C6	44 degrees Downward	3
PF69EW	-41	5
PGYWV8		
PTRNC6	45	
Q23Y93	44.4	2.6
Q3RB42	40	5
Q3VXG9	44	3
Q3ZB9C	43	5
RN96BY	43	5

TABLE 3 - Vertical

WebCode	Angle Measurement	Uncertainty (in degrees)
RYRKE2	43.0	2.6
T6DWQ9	44.43	5
VB8XN6	45	5
VRWTFV	45	5
W9KLH8	43 degrees	
WBBKZC	45	5
WLN3CF	(-) 43	
WM2EC7	43	5
WVK78	41.65	1
WZ9HFF	47	5
XCZD9Z		
XE476K	50	5
XMXCXL	45.7	2
XNR2ZU		
YG8C26	43	5
ZMNCT3	45	5
ZY3FVR	47	5
ZZV6HT	44.2	2.6

# Conclusions

## TABLE 4

WebCode	Conclusions
22KQQB	Trajectory measurements were documented and collected. The following possible bullet path was determined: The projectile entered the garage wall partition through Side 1 and exited through Side A. A possible lead wipe was observed at the top of the impact on Side 1, also indicating a likely entry point of the projectile. The direction of travel of the projectile, from the shooter's perspective, was from right to left at approximately 73 +/- 5 degrees from the wall (or 17 +/- 5 degrees from azimuth), and at a downward angle of approximately 44 +/- 5 degrees. All measurements are approximate.
23EE97	The holes in the partition are consistent with the passage of a projectile entering the partition from side 1 from an upward to downward direction at approximately 46 degrees downward from the horizontal plane and from right to left (when facing side 1 with the vertical partition as the starting reference point) at approximately 71 degrees clockwise in the horizontal plane. The projectile would have exited the partition from side A.
24R7Y2	[No Conclusions Reported.]
2HBT8E	When viewed from side "1" of the submitted partition wall section: One semi-circular, perforating entrance defect with a smooth margin at the top, in the side labeled "1" of the submitted partition wall section. A gray in color marginal abrasion is visible around the periphery of the upper portion of the defect. The defect at the outer margin measures approximately 1.2 cm x 9 mm. The defect is approximately 6 cm from the right side and approximately 13.3 cm upward from the bottom. When viewed from the opposite side, labeled "A", of the submitted partition wall section: One generally rectangular, perforating exit defect. The perimeter of the defect has wood broken away from the surface at the periphery, with a rough margin, and wood protruding outward at the upper margin. The defect at the outer surface measures approximately 2 cm x 1.2 cm. The defect is approximately 6.8 cm from the right side and approximately 5 cm upward from the bottom. Trajectory is side "1" to side "A", right to left and downward: Horizontal angle approximately 72 degrees right to left, +/- 5 degrees; vertical angle approximately 45 degrees upward from the horizontal plane, +/- 5 degrees. Angles were determined using a trajectory rod centered via centering cones through the corresponding entrance and exit defects. An angle finder was utilized to determine the vertical angle and a 180 degree protractor and plumb bob were used to determine the horizontal angle.
2NGCNR	The section of partition wall (item 1) is a wooden box ~ 5 3/4" tall by 6" wide and 3" deep. I observed a hole on the front side and on the back side of item 1. The front side hole has characteristics of a bullet hole entrance and the back side hole of a bullet hole exit. The entrance hole tested presumptively positive for lead. The center of the entrance hole is ~ 1/2" from the top edge of the box and 3 1/2" from the left edge of the box. This hole is ~ 1/2" top to bottom and 5/16" side to side. The center of the exit hole is ~ 3 3/4" from the top edge of the box and 3 1/2" from the left edge of the box. This hole is ~ 1/2" top to bottom and 5/16" side to side. Using a fiberglass trajectory rod, a zero edge protractor, and an angle finder, the vertical and the azimuth were taken. The path of the bullet was downward and right to left. The vertical angle component is downward, 45 degrees down from vertical or 45 degrees up from horizontal. The horizontal angle component is right to left, 17 degrees from perpendicular.
3KFJB9	1. The section of the partition wall displays two holes. 2. The bullet that generated the holes produced a trajectory from outside to inside, left to right, front to back and downward. 3. The entrance hole was identify in label 1 on the box. 4. The angles of the bullet trajectory on the horizontal axis is 75 degrees and on the vertical axis 45 degrees, both measurements with an uncertainty of +/- 3 degrees.
47A6A3	As a result of this examination it was determined that a projectile has perforated the portion of the garage wall entering on side 1 and exiting from side A. When facing side 1, the projectile has travelled from right to left and downward.

TABLE 4

WebCode	Conclusions
4FFU87	D-1- One (1) oval bullet hole approximately 10mmx20mm in size. Located on side "1", approximately 5" up from the bottom of the wall and approximately 2 1/8" in from the right-side edge of the wall. D-1 is consistent with a bullet perforating the plywood wall and traveling downward at approximately 43-degree vertical angle and right to left at approximately 70-degree horizontal angle. The bullet traveled approximately 3" through the wall exiting the plywood wall on side "A" (D-1a) approximately a 7mmx7mm non-descript bullet hole, located approximately 2" up from the bottom of the wall and approximately 3" from the right-side edge of the wall. No bullet was recovered.
676RHY	A firearm bullet passed through the item 1. The entrance is located on the side "1" and the exit hole is located on the side "A" This shot has a downward trajectory of approximately 42.5 degrees and a azimuth angle of approximately 74.2 degrees from right to the left. The uncertainty of measurement is +/- 5 degrees.
6BF6ZX	The trajectory is described regarding 3 references planes: horizontal plane (parallel to top and bottom faces), longitudinal plane (parallel to 1 and A faces), transversal plane (perpendicular to both other planes). The bullet progressed through the box from face 1 (entrance hole) to A (exit hole) on an axis oriented downward with an angle of 45°, from horizontal plane, and from right to left when following the bullet path with the angle of 20° from the transversal plane.
6CATEM	The result of trajectory analysis: 1. The size of the sample partition wall is 15.1 centimeters height 14.7 centimeters width and 7.8 centimeters depth 2. the position of hole on label 1 side is above from bottom side by 12.6 centimeters and far from left side (with arrow mark) by 5.7 centimeters and the size of the hole is 1.0 centimeters width and 1.5 centimeters height 3. the position of hole on label A side is above from bottom side by 4.4 centimeters and far from left side (with arrow mark) by 8.4 centimeters and the size of the hole is 0.8 centimeters width and 1.0 centimeters height 4. The trajectory is from label 1 side to label A side with downward angle by 41.71 degrees from ground and from right to left angle by 17.66 degrees
6CCHMQ	[No Conclusions Reported.]
6D776L	The perforating defect in the garage wall was traveling from right to left at an approximately 43 degree downward angle, and 104 degree horizontal angle.
6PFYGY	The direction of travel of the projectile thru Item 1 was determined to be from side 1 to side A, right to left and downward. As measured from entrance side (side 1), the vertical angle was determined to be -41 degrees. As measured from the right edge of side 1 towards the left side, the azimuth angle was determined to be 74 degrees.
6PJLU7	The trajectory will be reported as: 1. Side 1 contains the bullet entrance hole. 2. The bullet traveled in a right to left, and downward trajectory through the wall. 3. The horizontal (azimuth) angle is approximately 70 degrees from right to left. The vertical angle is approximately 46 degrees down.
6RQL9L	Pathway A (including impacts A, A1) is consistent with a bullet traveling from side "1" to side "A", right to left, and in a downward direction.
6ZH2XP	An elliptical-shaped perforating entrance bullet defect (defect 1) was on side '1' of the submitted partition box. The defect was located 92mm over from the left edge of the box and 117mm up from the bottom. The bullet exited the back of the box (side 'A'). The general directionality was from side '1' to side 'A', 45.1 degrees +/- 2.6 degrees downward, and right to left (azimuth 71.9 degrees +/- 2.6 degrees).
7BBZ3Z	22-5620 CTS Shooting Reconstruction: A wooden box approximately 5 3/4 inches square and approximately 3 inches thick with following defects observed: A: An oblong entrance hold perforating the surface marked as 1 located approximately 5 inches up from the ground and approximately 2 1/4 inches in from the right edge when facing the surface. The top of the defect had dark discoloration and the material was pushing inward. A1: An irregular shaped exit hole perforating the surface marked as A located approximately 1 1/2 inches up from the ground and approximately 3 1/4 inches in from the left side when facing the surface. The edges of the defect were pushed out and splintered. The trajectory had a right to left and downward directionality.

TABLE 4

WebCode	Conclusions
7BDPB4	Side one of the wooden block has an apparent bullet entry hole and side A has an apparent bullet exit hole. The bullet traveled through the wooden block in a downward direction at a vertical angle of approximately 47 degrees. It traveled from right to left at a horizontal angle of approximately 71 degrees.
7F8R9C	The probability of single gunshot cannot be ruled out. As the bullet entry hole observed on the site "1" of the box and the exit hole on the site "A" of the box were observed consistent. Both holes are suggesting that bullet is moving from right to left and in downward direction.
7KM2JV	The direction of travel of the bullet through the section of the wall was a slight right to left with a downward angle.
7PXAN7	The side of the wall labeled "1" has a perforating entrance hole consistent with the passage of a projectile. The projectile traveled through the wall at a downward angle of approximately 42 degrees and in a right to left direction of approximately 73 degrees.
8DGRNM	The bullet traveled through the section of the partition from side 1 to side A at a downward angle of approximately 43° and at a right to left angle of approximately 17° from the perpendicular of the surface of the wall. The reported measurements are for descriptive purposes and are not quantitative forensic test results.
8X4CPW	Defect side 1 entrance (3/8 inch diameter) located 1/2 inch below the top edge of the wooden box and 2 1/4 inches left of the right edge of the wooden box. No fouling was observed visually. No powder grains were observed visually. A wipe-off rim was observed visually. The presence of a wipe-off rim indicates that defect side 1 is an entrance defect. Defect side A exit (1/4 inch diameter) located 3 1/2 inches below the top edge of the wooden box and 2 3/4 inches left of the right edge of the wooden box. No fouling was observed visually. No powder grains were observed visually. No wipe-off rim was observed visually. The bullet traveled through the wooded box, entering side 1 and exiting side A. The direction of travel of the bullet was 18 degrees from the perpendicular right to left and 43 degrees downward.
8YWCKM	The bullet path is consistent with a bullet that entered side 1 of the wall section (Item AD) and exited side A with a downward angle of approximately 44 degrees from horizontal and traveling right to left at an angle of approximately 73.5 degrees from the wall surface. The distances and angles reported are used as descriptors and are not meant to be interpreted as quantitative forensic results.
9B9UZW	The box has sustained perforating damage caused by a bullet entering side 1 and exiting side A. The track is right to left, and downwards
9F3RM3	Item 1 had two defects that appeared consistent with damage from a projectile. The side labeled 1 appeared to be the entrance, and the side labeled A appeared to be the exit. A trajectory rod was placed, and measurements were taken. The projectile path was right to left and downward. Vertical Angle: 46 +/- 5 degrees Horizontal (Azimuth) Angle: 70 +/- 5 degrees (from baseline) The reported uncertainty of measurement (+/- 5 degrees) is generally accepted in the field of shooting reconstruction.

TABLE 4

WebCode	Conclusions
9W7KU3	On Wednesday, August 10, 2022 at approximately 1000 hours, I took custody of a white cardboard box for a Collaborative Testing Services (CTS) "Shooting Reconstruction-Angle Determination" proficiency test from Quality Manager [Name]. A [Laboratory] Property and Evidence form was completed in order to document the chain of custody. On Monday, August 15, 2022 at approximately 0900 hours, I noted the white cardboard box contained one (1) section of a partition wall (crime scene (CS) 1) from a garage in which a shooting was said to have taken place. The wall section was labeled "Side 1," "Side A," and "Top" for orientation purposes. The wall section appeared to contain two (2) suspected bullet defects. Both suspected defects were photographed. The bullet defect on Side 1 appeared to be an entry defect with the corresponding exit defect on Side A. A presumptive check for the presence of lead was completed using a "Lead Check" swab according to the manufacturer's instructions on the suspected entry defect. The swab indicated positive for the presence of lead. A flight path rod was inserted through both defects and the vertical and horizontal angles were determined. The bullet appeared to enter Side 1 at an approximate angle of 76 degrees, right to left and at an approximate 47 degree downward angle. Upon completion of documentation, all photographs were transferred to a digital versatile disk (DVD, CS 2). I secured CS 1 – 2 in my temporary evidence storage locker, to which I maintained the key. At approximately 1500 hours, I relinquished custody of CS 1 – 2 to Quality Manager [Name]. A [Laboratory] Property and Evidence form was completed in order to document the chain of custody.
B2RZUT	Bullet path labeled A entered the garage partition wall at a downward angle and traveled from right to left.
BHKQX3	The shooter fired downward in a right-to-left direction. The bullet perforated the garage partition wall, entering side 1 and exiting side A.
BUCGCE	Pathway FB (including impacts FB, FB1) is consistent with a bullet traveling from side 1 to side A, right to left and in a downward direction.
C7M7RV	The holes in the partition wall (Item 1), were created by the passage of a single bullet. This bullet entered the partition wall (Item 1) on the side labelled "1" and exited from the side labelled "A". The bullet travelled downward at a vertical angle of approximately $44 \pm 5$ degrees and at a horizontal angle of approximately $71 \pm 5$ degrees from right to left (viewed facing the side labelled "1").
C9P8RT	The apparent trajectory of the bullet that created the holes (when facing the front of the box) was front to back, right to left, and downward. The trajectory was determined using a trajectory rod and the angles were determined using a protractor and inclinometer.
CEDUKD	This bullet perforated the box from defect 1 (primary impact) through defect A. The bullet path has a horizontal angle of 72 degrees and a vertical angle of -46 degrees.
CFQG3R	A wood box labeled Test No. 22-5620 was examined and observed with bullet related damage. A bullet hole was observed on side "1" and a corresponding exit hole was observed on side "A" of the wood box. The bullet traveled downward in a right-to-left direction, passed through the box from side "1," and exited out side "A."
CG8H7U	[No Conclusions Reported.]
CTWGTP	The path of the suspected bullet's travel was determined to be right-to-left at $77.3^\circ$ degrees from the vertical plane and at a $40.2^\circ$ downward angle from the horizontal plane. Trajectories measured in this report reflect a $\pm 5^\circ$ measurement of uncertainty.
CXPG97	The bullet entered on side 1, with the bullet hole labeled "A" and exited on side A, with the bullet hole labeled as "A1". The bullet entered the box from right to left at a downward angle.
CZW2VL	Pathway T (including impacts T, T1) is consistent with a bullet traveling from side 1 to side A, right to left, and in a downward direction.

TABLE 4

WebCode	Conclusions
D3HZNA	On August 25, 2022, I performed a trajectory analysis on item #1 which included angle determination at the [Laboratory] Evidence Garage. Note: Positive vertical angles represent an upward trajectory while negative vertical angles represent a downward trajectory. In addition, horizontal angles were measured from right to left (at defect 1). Defect 1: Wooden box This bullet initially perforated the wooden box at defect 1 (primary impact) and traveled downward perforating the wooden box at defect A (secondary impact). The bullet path had a vertical angle of -43 degrees and a horizontal angle of 73 degrees.
D4PFW2	Item AD was examined and the approximate bullet path trajectory was determined. The bullet entered through "Side 1", traveling downward at a 42-52° angle from horizontal and from right to left at 15-25°, from the shooter's perspective to the wall, and exited out of "Side A". The angles reported are used as descriptors and are not meant to be interpreted as quantitative forensic test results.
DDYPPZ	A single bullet had passed through the partition wall, entering on side 1 and exiting from side A. The causative bullet had been travelling from right to left (approximately 19 degrees +/- 7 degrees from perpendicular to the wall and downwards (approximately 43 degrees +/- 7 degrees from the horizontal).
DF6CVD	The box damaged by one bullet, approx. diameter - 7-8 millimeters. The direction of the bullet is from "1" to "A". The lesion is directed from top to bottom with 42 degrees and from right to left with 15 degrees.
DGYZHE	The bullet causing the observed defects entered side 1 of the partition and exited out side A. The trajectory of this bullet was Side 1 to Side A, right to left (72.0 degrees), and downward (46.5 degrees). These angle measurements contain uncertainty of +/- 2.6 degrees.
DHVBF4	The evidence consisted of a wooden box labeled 22-5620. One side was labeled 1 and the other side is labeled A. The entry hole was on the side labeled 1. It was an oblong hole with internal beveling and a leading edge on the top of the hole, indicating a downward angle. The hole was 5" up from the bottom of the box and 3.75" over from the left side. The exit hole was on the side labeled A. It was a hole with external beveling and chipped away wood. The hole was 2" up and 2 11/16" over from the right side. The bullet traveled from right to left at a 15 degree angle from side 1 to side A at a downward angle of 44 degrees.
DL9E3Y	NARRATIVE: Test Report: This laboratory report contains the conclusions, opinions, and interpretations of the member whose initials/signature appears on the report. Results relate only to the items tested. Unless otherwise noted, all activities performed at [Laboratory]. This is a supplement to the original report. On 8/15/2022 [Name] provided me with a box (item #1) for trajectory analysis angle determination. Description: Item # 1: A white cardboard box sealed with red "evidence" tape containing one square plywood box. The box was labeled on three sides with the following stickers: "Test No. 22-5620 Top" hereafter referred to as "top". "Test No. 22-5620 1" hereafter referred to as "side 1". "Test No. 22-5620 A" hereafter referred to as "side A". The test box measures approximately 5 3/4" wide by 5 3/4" tall and approximately 3" in depth. The box has a hole on side 1 and side A. Both holes appear to be possible bullet defects. The hole on side 1 is circular with ragged edges where the plywood splintered. The edges of the hole appear to be bent inwards toward the interior of the box. There is a gray circular mark along the top rim portion of the hole on side 1. The center of the hole is approximately 2 1/4" from the right side of the box, and 7/8" from the top of the box. The hole itself is approximately 5/16" wide by 3/8" tall. The hole on side A is located near the bottom of the box. The side A hole has a larger splintered area than side 1. The splintering appears to be pushed outward from the box, with several larger chunks of plywood missing. The center of the hole is approximately 1 3/4" from the bottom, and 2 5/8" from the right side. The hole itself is approximately 2/8" wide by 5/16" tall. The larger splintered area measures approximately 1 9/16" wide by 7/8" tall. Based on the direction of the wood splinters and the appearance of the holes, it is likely that the side 1 hole is the entry point, and the side A hole is the exit point. To determine the angle of the path of the bullet, a trajectory rod was inserted into the hole on side 1 continuing through the hole on side A. The vertical path of the bullet was determined to be 43 degrees downward, and the horizontal path of the bullet was determined to be 79 degrees from right to left. No further at this time.

TABLE 4

WebCode	Conclusions
DMP96U	The projectile perforated the wooden box entering on the side labeled 1 and exited the box on the side labeled A. The projectile traveled from right to left with an entrance angle of ~72 degrees and downward angle of ~44 degrees.
DQZHTH	There is a single perforating bullet hole on the partition wall of the garage. The bullet entrance was located on the side marked "1" with visible bullet wipe present on the upper edge of the bullet hole. The bullet traveled right to left, in a downward trajectory.
DTU6TZ	The side of the box with the label that read, "Test No. 22-5620 1" had an oval hole that had gray material around the top margins of the defect and was located near the upper portion of the wall. This hole was tested for the presence of lead using sodium rhodizonate and 5% hydrochloric acid; the results of these tests were positive. This hole was determined to be the entrance hole of the projectile. The opposite side of the partition wall that had the label that read, "Test No. 22-5620 A" had an irregular shaped hole with jagged margins and was in the lower half of the wall. This hole was tested for the presence of lead using sodium rhodizonate; the result of this test was negative. This hole was determined to be the exit hole of the projectile. A probe was placed through these two holes to illustrate the path of the projectile. The path of this projectile was determined to be downward and from right to left as one views side 1 of the wall.
DUNUU9	The trajectory was determined to be downward and right to left
EKDT98	A bullet appeared to have perforated the wall, entering the side labeled "1" and exiting the side labeled "A". The path of the bullet's travel was downward and from right to left.
EQHRKX	Two (2) apparent bullet defects were observed in the section of partition wall submitted for analysis, and the bullet path was labeled A during processing. The apparent entry bullet defect (labeled A1) was located on Side 1 of the partition wall. The apparent exit bullet defect (labeled A2) was located on Side A of the partition wall. The horizontal (azimuth) angle for bullet path A was 72 degrees and the direction of travel was from right to left. The vertical angle for bullet path A was 43 degrees and the direction of travel was downward.
ETKRFN	The submitted section of partition wall was found to have a pair of defects. A single bullet likely perforated this section of the wall on surface '1' and exited from surface 'A'. The trajectory, viewed facing surface '1', was estimated to be 68° to 78° from right to left, and 38° to 48° downwards.
F38BC9	Synopsis: Responded to the listed location and performed Trajectory Determination analysis on a section of the partition wall. Observations: A wooden section of partition wall was labeled as Test No. 22-5620. The partition wall was labeled with stickers for Test No. 22-5620 Top, Test No. 22-5620 1 (side), and Test No. 22-5620 A (side). One bullet hole (A) was located on side Test No. 22-5620 1. Results: Identifier: A to A2. Description: Perforating bullet hole on Side 1, Exits Side A. Directionality: Right to Left; Downward. Horizontal Angle of Incidence: 70°. Vertical Angle of Incidence: -43.8°.
F3RV3D	The holes in sides 1 and A of Item 1 are consistent with the passage of a single bullet. The bullet first struck/entered the wooden box/garage partition on side 1 and exited through side A. When the bullet struck side 1, it was traveling downward (up to down) and from right to left (as facing side 1). I measured the horizontal angle to be approximately 68 degrees (from the right side as facing side 1) and the downward angle to be approximately 46 degrees. Any reported measurements are approximate and for descriptive purposes only. The measurements are not quantitative forensic test results.
F7B2MU	The trajectory traveled from right to left and at a downward angle.
FUFRYK	The bullet was traveling right to left at a horizontal angle of approximately 75 degrees (+/- 5 degrees) and a downward vertical angle of approximately 43 degrees (+/- 5 degrees).
G8FVXK	The projectile entered the wood box on side 1 and exited on side A. The projectile traveled from right to left at a downward angle.



TABLE 4

WebCode	Conclusions
GD4DDG	Pathway A (including impacts A, A1) is consistent with a bullet traveling from side "1" to side "A", right to left, and in a downward direction.
GW2QVU	Trajectory A – entry into side 1 and exits from side A. Trajectory A is traveling at a downward, vertical angle of -44 degrees with a +/- 5 degree reasonable measurement variance; and traveling right to left, with an azimuth angle of 71 degrees with a +/- 5 degree reasonable measurement variance.
H29MAN	The label one (1) on the box represents the entrance hole (located at the top, right side) and the letter A represent the exit hole (located in the middle area, near to the bottom part. The aforementioned box represent a section of the partition wall from a garage in which a shooting took place. The shooting trajectory that is the direction of travel of the bullet through the representative box are: Right to Left since Number one (1) Downward to letter A.
HLHJRY	The item 1/AD box was struck by a bullet that entered on side 1 and exited on side A. The bullet was traveling downward at an approximately 45 degree angle from horizontal and from right to left at an approximately 19 degree angle. The reported angles are used as descriptors and are not meant to be interpreted as quantitative forensic test results.
HNKHZ7	This bullet perforated the partition wall entering at Defect 1 and exiting at Defect A. The bullet path has a horizontal angle of 76 degrees (measured right to left) and a vertical angle of -42 degrees.
HUCRA6	The path of the bullet's travel was determined to be approximately right to left and at a downward angle.
JRD2GV	After examining the wooden box, the bullet entered the wooden box through side 1 and exit through side A. The horizontal (Azimuth) angle was measured at 13 degree from perpendicular, 77 degree from right to left and 103 degree from left to right . The vertical angle was found 43 degree downwards. The uncertainty level in degrees was noted as +/-5 degree
KKC9L7	We do not issue trajectory reports, however we would include wording such as "Approximate trajectory measurements were recorded."
KVWFJB	A hole that appears as a bullet entry hole in the wall marked 1 and a hole that appears as a bullet exit hole in the wall marked a. The general firing direction from the entrance hole is forward and from right to left at a horizontal angle of 75 (5+/-) degrees (where angle 0 represents firing direction from right to left and angle 180 represents firing from left to right) and from top to bottom, at an angle of 135 (5+/-) degrees (when angle 0 represents a shooting direction from the bottom up and an angle of 180 represents a shooting direction from the top down).
LB27Z7	Visual examination of the Item 1 section of partition wall revealed the following: Side 1 Hole - One oblong entrance bullet located in the approximate top right quadrant of the Side 1 partition wall. Side A Hole - One oblong/irregular shaped exit hole with surrounding damage/splintering of the wood located in the approximate bottom half center area of the Side A partition wall. The fired bullet entered the Side 1 hole and exited the Side A hole, traveling from Side 1 to Side A of the Item 1 wall, from the right to the left at a horizontal angle of 17 degrees (+/- 5 degrees) right of perpendicular to the face of the Side 1 wall, and at a downward angle of 42 degrees (+/- 5 degrees). Note: Trajectory perspective is facing Side 1 of the Item 1 section of wall.
LCYGW9	Side 1 contained a perforating bullet entrance defect, Defect A, near the top right corner of the wooden box. An exit defect, Defect A exit, was on the lower, center portion of Side A. The azimuth angle was measured as 72.7-degrees in the right to left direction, and the vertical angle was measured as 42.0-degrees in the downward direction. Both of these measurements contain uncertainty of +/- 2.6-degrees (k=2, 95% confidence interval).
LKV8LP	Analysis of Trajectory 1 indicated the bullet originated from the top right of the side marked 1 and traveled from right to left at a downward angle exiting the bottom center of the side marked A.

TABLE 4

WebCode	Conclusions
MFRXNT	The bullet path is consistent with a bullet that entered side 1 of the wall section (Item AD) and exited side A with a downward angle of approximately 45 degrees from horizontal and traveling right to left at an angle of approximately 72 degrees from the surface of the wall. The distances and angles reported are used as descriptors and are not meant to be interpreted as quantitative forensic test results. All examinations were conducted using the methods outlined in TP-5.
MR8PC3	Two defects located on the wooden box (Defects 1 and A). Bullet Path: Defect 1 is the entry hole, bullet is traveling from right to left, goes through the box and exits at Defect A. Horizontal angle: 74 degrees; Vertical angle: -45 degrees Note: Positive vertical angles represent an upward trajectory, while negative angles represent a downward trajectory.
MUTPBJ	Our examination findings supports the hypothesis that the projectile went thru the "wall", entering the side marked "1" in a downward path, from right to left, and exited thru the other side of the wall marked "A". The vertical angle of the projectile path was measured and calculated to 43 degrees (+/- 2 degrees). The horizontal Azimuth-angle was measured and calculated to 74 degrees (+/- 2 degrees).
MVL79	Pathway B (including impacts B, B1) is consistent with a bullet traveling from side 1 to side A, right to left, and in a downward direction.
N6RR8Z	One section of a partition wall. A bullet entrance defect (T1) was observed on side 1, and a corresponding bullet exit defect (T2) was observed on side A. A general trajectory determination was performed; the path of the bullet was above to below and right to left.
N7LDZQ	The trajectory of the bullet was front (side 1) to back (side A), right to left, and downwards. The trajectory was determined using a trajectory rod and the angle was determined using a protractor and inclinometer.
NG33WB	Pathway B (including impacts B and B1) is consistent with a bullet traveling from side "1" to side "A", right to left and in a downward direction.
NNJVNZ	[No Conclusions Reported.]
P3U2C6	Item 1 section of partition wall has an entrance defect labeled "1" and an exit defect labeled "A". The bullet pathway through the section of partition wall is from right to left and downwards. The vertical angle was measured at ~ 44 degrees (+/- 3 degrees) downward from top to bottom facing the side of the entrance defect. The horizontal angle, or azimuth angle, was measured at ~ 72 degrees (+/- 3 degrees) from right to left and ~ 108 degrees (+/- 3 degrees) from left to right facing the side of the entrance defect.
PF69EW	Exhibit 1 was examined for apparent bullet strikes. Based on appearance and context, two (2) holes, one in either side of Exhibit 1, were determined to be an entrance (side 1) and exit (side A) of a single perforating bullet strike (labeled Strike A). A trajectory rod was passed through the bullet holes, and the trajectory of strike A was determined to be from right to left, at a downward angle. Images from the examination are being retained in the case record. Additional copies of the images may be produced on request. Exhibit 1 is being retained by this analyst pending your instruction. footnote: A perforating strike is one in which the projectile passes completely through the object.
PGYWV8	Pathway J (including impacts J, J1) is consistent with a bullet traveling from side 1 to side A, right to left, and in a downward direction.
PTRNC6	Side 1 of the section of wall has what appears to be an entrance hole. Side A of the section of wall has what appears to be an exit hole. The trajectory for the bullet that went through the wall is downward and from right to left. The vertical angle is approximately 45 degrees (downward) and the horizontal angle is approximately 73 degrees (right to left).
Q23Y93	There was a perforating entrance bullet defect to Side 1, with a corresponding exit defect to Side A. The direction of travel of the bullet was from Side 1 to Side A, at 44.4 degrees downward, and 70.7 degrees right to left. Both of these measurements contain uncertainty of +/- 2.6 degrees (k=2, 95% confidence interval).

TABLE 4

WebCode	Conclusions
Q3RB42	The wooden box (wall partition), item 1 contained two circular defects, one located on the front (side 1), and one located on the back (side A). Both defects were determined to be perforations consistent with the passage of a bullet. The defect on side 1 was determined to be an entry hole, while the defect on side A was determined to be an exit hole. The path of the projectile was determined to be downward and from the right to the left, entering from side 1, and exiting from side A.
Q3VXG9	A section of wall was received for analysis to differentiate a bullet exit hole from a bullet entrance hole, and also determine the azimuth and vertical angles at which the bullet perforated the target. The entrance side of the target was determined by the symmetrical lead-in mark or "shoulder" at the upper/right margin of the hole on side 1. Chips on the margin opposite the shoulder are also typically found on bullet entrance holes. The shoulder area also has blackening around the margin indicating a "bullet wipe" which is typically found on the first target struck by a fired bullet, or the bullet entrance hole in this case. Wood fibers pointing outward on side A along with missing layers of the wood laminate are characteristic of bullet exit holes, therefore it was determined that side 1 was the bullet entrance and side A was the bullet exit. The vertical angle was calculated three different ways: Tangent function, sine function, and using an angle finder. The tangent function involved measuring the top-most margin of the bullet entrance from the top of the target which was approximately 1.5 cm from the top. The top-most margin of the bullet exit was measured to be approximately 9.5 cm from the top of the target. The width of the target was measured to be approximately 7.75 cm. Subtracting 1.5 from 9.5 gives a difference of 8 cm, which would be the adjacent side of the triangle. The width of 7.75 cm is the opposite side of the triangle. 7.75 divided by 8 gives a quotient of .98675, the arc tangent of which is 44.09, or 44.09 degrees with zero being the top of the bullet entrance hole. The sine function involved measuring the bullet entrance hole's width and length. The width was approximately .9 cm and the length was approximately 1.25 cm. dividing .9 by 1.25 gives a quotient of .72, the arc sin of which is 46.054, or approximately 46.05 degrees with being at the top of the bullet hole. The target was placed on an examination table with the "Top" marking at the top, and a trajectory rod was inserted into the target to connect both the entrance and exit holes. The top of the target was approximately level according to the angle finder which was then placed on the trajectory rod and gave a reading of approximately 45 degrees. In this case, the zero plane is perpendicular to the target's facade due to the functionality of the angle finder. The azimuth angle was calculated using a zero-edge protractor and also using trigonometry. A zero-edge protractor was placed level and horizontally, against the target's facade with the zero line at the left side of the trajectory rod, and a plumb bob was dropped, connecting the left side of the trajectory rod to the protractor. The reading was approximately 19 degrees when zero is perpendicular to the target surface which is the complementary angle of 71 degrees when zero is the target surface to the right of the bullet entry hole. The trigonometric function was also applied with the above target width of approximately 7.75 cm as the opposite leg of the triangle. A measurement of 9 cm was recorded to represent the distance between the left margin of the bullet entrance hole on side 1 and the left side of the target. with the same side (appearing to be the right side when the target is turned around) of the bullet exit hole measuring approximately 6.25 cm from the same side of the target. The difference between 9 and 6.25 is 2.75 which is the adjacent leg of the triangle. 7.75 divided by 2.75 gives a quotient of 2.818, the arc tangent of which is 70.46, degrees. When the legs are inverted and the opposite is the adjacent and adjacent is the opposite, the result is 19.53 degrees, corroborating the finding from the zero edge protractor. All measurements are approximate.
Q3ZB9C	I observed a perforating impact in the item with a possible projectile path from the side labeled "1" through the side labeled "A". The direction of travel is -43° (downward) to the horizontal plane (+/- 5°) and 71° from right to left to the vertical plane (+/- 5°).
RN96BY	The submitted wall section exhibited two apparent bullet defects consistent with a bullet having passed through the wall from side 1 to side A, at a downward angle of approximately 43 degrees, and approximately 18 degrees right to left.

TABLE 4

WebCode	Conclusions
RYRKE2	The bullet struck the box approximately 1 inch below the top edge and approximately 2 1/8 inches to the left of the right edge of the box. The vertical angle of the bullet's trajectory was approximately 43° ( $\pm 2.6^\circ$ ) downward, and the azimuth angle was approximately 71.8° ( $\pm 2.6^\circ$ ) out as one views the box. The bullet's direction of travel was from side "1" to side "A", right to left, and downward. The uncertainty of trajectory angles is expanded using a coverage factor $k=2$ for a level of confidence of 95%, assuming normal distribution.
T6DWQ9	The vertical angle is 44.43 degrees above the horizontal plane with a downward trajectory. The horizontal angle is 79.92 degrees with a right to left trajectory. The measurement of uncertainty is +/- 5 degrees.
VB8XN6	The bullet that struck the wall entered at BS1 and exited at BS2, with a downward trajectory of 45 degrees and right to left trajectory of 70 degrees.
VRWTFV	The bullet entered side labeled (1) of the box and exited the side labeled (A). The horizontal angle measurement is (72 $\pm$ 5) degree from Right to Left and the vertical angle downward measurement is (45 $\pm$ 5) degree.
W9KLH8	Bullet path, labeled "A", entered the garage partition wall, traveled at a downward angle from the right to the left.
WBBKZC	The trajectory was from right to left (approximately a 72 degree angle) and downward (approximately a 45 degree angle).
WLN3CF	The bullet was descending downward, and approximately 73 degrees right to left.
WM2EC7	Bullet strike 1 (on side 1) is a perforating entrance hole. It is elliptical in shape and bullet wipe is present. The projectile travelled downward at a ~43 degree (+/- 5 degrees) angle, and right to left at ~72 degrees (+/- 5 degrees) from the surface of the box/partition section. Bullet strike 2 (on side A) is the associated perforating exit hole.
WVK78	[No Conclusions Reported.]
WZ9HFF	The bullet struck the box on the face labeled "1" and exited from the face labeled "A". The trajectory of the bullet through the box was downward at approximately 47 degrees and right-to-left at approximately 71 degrees.
XCZD9Z	Pathway A (including impacts A, A1) is consistent with a bullet traveling from side "1" to side "A", right to left, and in a downward direction.
XE476K	Damage to the wall, Exhibit 1, is consistent with having been caused by a projectile entering "side 1" and exiting "side A", traveling from right to left and downward.
XMXCL	We consider angle 0 to be the perpendicular angle to impact plane (parallel to the ground). The right to left direction is taken with respect to the shooter. The measurement has been carried out with manual devices and with a 3D Laser Scanner (Faro Focus S350). The results presented in the test are those measured with the 3D scanner. The +/-2 angle is due to the fact that the diameter of the exit hole causes a cone of trajectory to exist.
XNR2ZU	It is possible to determine the trajectory, identifying side 1 as left and side A as right of the wooden box, writing it as follows: 1. An entry hole produced by a projectile fired from a firearm, located on the upper left side of the wooden box of proficiency ITEM 22-5620. With a downward angle of 48°. side 1 A. A gunshot projectile exit hole located at the bottom of the right side of the proficiency ITEMS 22-5620 wooden case. A side. Final wording: 1. Letter A, an entry hole produced by a projectile fired from a firearm, located in the upper part of the left side of the wooden box of proficiency ITEMS 22-5620. With a trajectory from left to right, from top to bottom, slightly from back to front, with a downward angle of 48°, the projectile in its path produces an exit perforation, identified as A1, located in the lower right part of the box. described wood, getting lost in the exterior.

TABLE 4

WebCode	Conclusions
YG8C26	The trajectory in Item 1 traveled at a downward angle in a right-to-left direction, entering side "1" and exiting side "A".
ZMNCT3	At BS A there is a perforating irregular entrance hole on side "1". The hole has bullet wipe present. There is an exit hole on side "A", irregular in shape with rough/blown out edges. BS A had a vertical angle of ~45 degrees downward and an azimuth angle of ~69 degrees from right to left.
ZY3FVR	The direction of travel of the bullet through the box was downward and right to left Horizontal Angle was 104 degrees and Vertical Angle was 47 degrees
ZZV6HT	A perforating bullet defect was in the wooden box. The bullet entered on side 1 and exited on side A. The directionality of the bullet was right to left and downwards. The azimuth angle was measured at 72.5° in the right to left direction, and the vertical angle measured 44.2° in the downward direction. Both of these measurements contain uncertainty of $\pm 2.6^\circ$ ( $k=2$ , 95% confidence level).

## Additional Comments

TABLE 5

WebCode	Additional Comments
22KQQB	Methods used: Scaled diagramming for horizontal and vertical angle = 73 degrees R-L, 45 degrees down. Photographic method for horizontal and vertical angle = 73 degrees R-L, 47 degrees down. Inclinometer for vertical angle = 44 degrees down
6CCHMQ	Incident angle (ellipse method): 37 degrees Uncertainty: 3 degrees
6PJLU7	EXAMINATION AND RESULTS I examined the evidence for this case on 07/15/2022. I was asked to examine a section of a partition wall from a garage where a shooting occurred. I was asked to determine which side of the wall the bullet entered, the general direction of travel of the bullet, and the horizontal (azimuth) and vertical angles of the trajectory. I photographed both sides of the wall for general documentation purposes. I also photographed the wall with a trajectory rod in place to approximate the horizontal (azimuth) and vertical angles. Side 1 appears to contain the bullet hole entrance based on the deformation of the wood and possible bullet wipe around the top of the hole. Side A appears to contain the bullet hole exit based on the deformation of the wood. A trajectory rod was placed through both bullet holes to estimate the bullet trajectory measurements. The vertical angle measured approximately 46 degrees in a downward trajectory. The horizontal (azimuth) angle measured approximately 71 degrees from right to left facing side 1 (entrance hole). I printed the photographs to estimate the same trajectory measurements and used them to measure both angles. The vertical angle measured 46 degrees in a downward trajectory. The horizontal angle measured 69 degrees from right to left facing side 1 (entrance hole). I took the average of both vertical angle measurements $(46 + 46)/2 = 46.0$ degrees down. I took the average of both horizontal (azimuth) angle measurements $(71 + 69)/2 = 70.0$ right to left. The trajectory will be reported as: 1. Side 1 contains the bullet entrance hole. 2. The bullet traveled in a right to left, and downward trajectory through the wall. 3. The horizontal (azimuth) angle is approximately 70 degrees from right to left. The vertical angle is approximately 46 degrees down. DISPOSITION: Submission 001 will be returned to the Evidence Section of the laboratory. All photographs will be stored electronically on a secure network drive.
6ZH2XP	$k=2$ , 95% confidence interval
7BBZ3Z	This laboratory does not report out measurement uncertainty.
7BDPB4	Measurements given are approximations. Uncertainty has not been calculated for trajectories at this laboratory.
7KM2JV	Horizontal angle measured between the rod and wall (from left to right).
9B9UZW	When comparing results from different laboratories, some addition uncertainty could be expected due to test sample differences
B2RZUT	Uncertainty of measurement fields were left blank as our unit does not calculate uncertainty of measurement for angle determination.
CEDUKD	Note: Horizontal (azimuth) angles were measured from right to left with respect to the side labeled 1. Positive vertical angles represent an upward trajectory while negative angles represent a downward trajectory.
D4PFW2	Our laboratory's technical procedures do not conclude a specific, measured uncertainty for this type of examination. We typically report the angles with a range of +/- 5 degrees but are also required to state the disclaimer of the angles and measurements being used as descriptors.
DHVPF4	All measurements are approximate and descriptive in nature and do not represent a test result.
DTU6TZ	Our laboratory does not report the measured angles as an uncertainty of measurement budget has not been performed.

TABLE 5

WebCode	Additional Comments
DUNUU9	Reported the negative symbol for the vertical angle measurement in the test as it would have been recorded in our notes per our manual. State Police Forensic Services Division is not currently reporting out angles.
EKDT98	We are not reporting numerical angle determinations or uncertainty in our analytical reports.
F38BC9	1. All reported angles of incidence include a $\pm 5^\circ$ uncertainty of measurement. 2. Positive (+) vertical angles are associated with shots upward, towards the sky. 3. Negative (-) vertical angles are associated with shots downward, towards the ground Methodology: Trajectory Determination. Trajectory Determination is the analysis of bullet impact characteristics to make conclusions in regard to direction of travel, shot sequencing, and/or angle of incidence. Report Limitations: 1. Opinions/interpretations within this report are based on the information provided at the time of scene processing or as a result of further investigation and/or experimentation. 2. Any additional information, statements, or evidence received after completion of this report may alter the results, opinions, and/or conclusions herein. 3. Projectile defects outlined in this report were assumed to be created during the shooting event under investigation and not as a result of a previous shooting event. 4. Uncertainty of Measurement: As shown in this report, trajectory angles are within the $\pm 5^\circ$ uncertainty of measurement. The coverage probabilities for the reported angles are approximately 99%; meaning the reported range will include the true value 99% of the time. 5. The curvature of a stable projectile's trajectory is minimal within 50 yards of the firearm so as to not be outside the $\pm 5^\circ$ uncertainty of measurement. Glossary of Terms: Angle of Incidence – The angle formed between the path of the projectile prior to impact and the plane of the impacted surface. Bullet Wipe – The discolored area on the immediate periphery of a bullet hole, caused by the transference of residues from the bullet's bearing surface. Horizontal Angle – The angle measured along a horizontal plane with the horizon line being $0^\circ$ and the angle increasing as it moves away from the horizon, up to $90^\circ$ at perpendicular. Inclinator – A measuring instrument used for indicating the incline of an object in reference to a vertical axis. Lead-In Mark – Partial elliptical mark created at the entry side of an impact site from the nose of the bullet first making contact with the surface material. Orthogonal – Characterized as an angle that is more perpendicular than oblique; typically associated with angles from $50^\circ$ to $90^\circ$ . Perforation – Indicative of a projectile impacting a surface and passing through the material, creating not only an entry defect, but an exit defect as well. Plumb Bob String / Line – A line or string with a weight attached to the end used to create a true vertical line. Protractor (Zero-Edge) – A measuring instrument consisting of an edge that lacks any tabs or protrusions, thus allowing the $0^\circ$ mark to be placed directly against a surface; an instrument consisting of a graduated arc for plotting or measuring angles and ultimately a projectile's flight path. Trajectory – The arched path of a bullet in flight depicting the relationship between the location of the firearm and the object struck. Vertical Angle – The angle measured relative to a vertical plane, with the vertical plane being $90^\circ$ and the angle of incidence falling between $0^\circ$ (perpendicular) and $90^\circ$ .
F3RV3D	No uncertainty is required to be reported by our technical procedures, so I wrote "n/a". The scenario is the same as in 2021 and 2019.
F7B2MU	Our agency does not calculate measurement of uncertainty for trajectories.
H29MAN	It was very helpful for me to reinforce the work I do on a daily basis. I would like more diversity of experiences to give feedback to Forensic Sciences that covers so many branches.
HUCRA6	[Laboratory] is not currently reporting the angles of trajectories.
KKC9L7	Uncertainty measurement is not calculated, but just an accepted value in our unit.
MUTPBJ	Usually our report contains pictures, graphic models or drawings with arrows and descriptions that renders the wording as above somewhat unnecessary, or at least a bit different.
N6RR8Z	our organization does not currently include specific angle measurements in reports
P3U2C6	Measurements taken with 5mm pink colored trajectory rod, angle gauge, zero-edge protractor and plumb bob.
PTRNC6	Angle measurements are used for descriptive purposes only and are not quantitative forensic test results.

TABLE 5

WebCode	Additional Comments
Q3RB42	Angle measurements are not typically included in the report but are documented in case notes. Our lab has not established an uncertainty for angle determination. Reported uncertainty is based on accepted approximate range among practitioners in the field.
Q3VXG9	Resources: Haag, M. G., Haag, (2011). Shooting Incident Reconstruction (2nd ed.). L. C., & Academic Press San Diego ; Oxford: Academic Press Is An Imprint Of Elsevier, Corp. Hueske, E. E. (2016). Practical Analysis and Reconstruction of Shooting Incidents (2nd ed.). Boca Raton, FL CRC Press
RN96BY	Note: the angles reported are as if facing side 1 of the wall section such that a line perpendicular to side 1 at the entrance defect would be 0 degrees up or down and 0 degrees left or right.
W9KLH8	The angles are not reported per our standard operating procedures and my unit does not calculate uncertainty of measurement for angle determination; therefore, the uncertainty of measurement fields are left blank.
WBBKZC	Lead bullet wipe was visible at the entrance site. Chemical tests were not undertaken for this test purposes.
XE476K	RESULTS: A bullet entrance hole was located in side "1" of the wall with an associated exit located on side "A" of the wall. The projectile path was determined to have a vertical angle of 50 degrees downward (from horizontal) and a horizontal angle of 20 degrees (from perpendicular) traveling from right to left.
XMXCXL	We found aproximate 1 degree diferences between manual mesuraments and 3D Scanner results.
XNR2ZU	The proper characteristics observed in the holes present in the wooden box, allow identifying the entrance and exit of the projectile route, determining a direction from left to right, from top to bottom; no difficulty determining lower, upper, back, or front sides. The DCC, in its ballistic trajectory procedure at the crime scene, does not determine patterns; therefore, in the proficiency test, this section was determined as "Not applicable".

-End of Report-  
(Appendix may follow)



## Test No. 22-5620: Shooting Reconstruction - Angle Determination

DATA MUST BE SUBMITTED BY **Oct. 11, 2022, 11:59 p.m.** TO BE INCLUDED IN THE REPORT

Participant Code: U1234A

WebCode: 22LG2Y

### Scenario:

Investigators have submitted a section of a partition wall from a garage in which a shooting took place. They are asking you to conduct your analysis using your laboratory's procedures.

### *Please note:*

-For this exercise, the sample contains a TOP label for orientation purposes.

-The sample has been labeled with two different characters (A and 1) in which participants can use as reference in reporting.

-Make sure to place the sample on a flat surface when measuring angles.

### Items Submitted (Sample Pack AD):

Item 1: A section of the partition wall which contains one entrance hole and one exit hole.

1.) Which label on the box represents the entrance hole?

A       1

2.) What is the direction of travel of the bullet through the box? (Select one from each column)

Left to Right

Upward

Right to Left

Downward

3.) Please record your angles below. (If the angle type below differs from your normal terminology, you may use your preferred terminology in the conclusions section of the data sheet.)

Angle Type (i.e. Azimuth, Vertical, Horizontal)	Angle Measurement (in degrees)		Uncertainty (in degrees)
Horizontal (Azimuth)	<input type="text"/>	±	<input type="text"/>
Vertical	<input type="text"/>	±	<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.*

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

**5.) 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 ASCLD/LAB, 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 ASCLD/LAB, ANAB, and/or A2LA. (Accreditation Release section below must be completed.)
- This participant's data is not intended for submission to ASCLD/LAB, 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.   
(Include ASCLD/LAB Certificate here)

A2LA Certificate No.

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

Authorized Contact Person and Title

Laboratory Name

Location (City/State)