

# The Glass Menagerie

Small towns across the United States are full of family run businesses, many in the third or fourth generation. In a small town not too far from here, there exists such a business. This business manufactures and sells various types of flint glass as dichromatic lenses used in reducing the focal differences between red and blue light known as chromatic aberration, as well as selling leaded glass to various medical supply houses.

The Owner, Vladimir Smudge started the company 50 years ago, shortly after entering the USA from Romania. Vlad, as his friends call him, has 4 Sons; Shad, Chad, Thad and Brad, all of which are active in the family business. Since the business manufactures 4 different types of flint glass, each of the Sons run one production line:

Son	Type of Glass	Index of Refraction
Shad	Arsenic Trisulfide Glass	2.04
Chad	Lanthanum Flint Glass	1.87
Thad	Extra-Dense Flint Glass EDF-3	1.72
Brad	Standard Flint Glass	1.6

Although Vlad loves his Sons, his heart has always truly belonged to his chihuahua, Brutus. Many times, Vlad would tell one of the boys to give up their seat at the table so Brutus could have it. Last Christmas, Vlad even gave Brutus the choicest piece of meat from the Christmas Turkey. Vlad routinely gives Brutus table treats such as thickened gravy and apple pieces. As a result, all of the boys hated that dog. In fact, they often joked about different ways they could terminate it.

Vlad attempted to run in the Memorial Day Marathon last year, but only managed to make it 8 miles where he promptly fell over from a heart attack. He was rushed to the hospital where he spent the next 3 weeks recovering. When he finally came home on Monday, June 23<sup>rd</sup>, he noticed his dog Brutus was missing. He searched the property frantically and finally found the partially decomposed body of the tiny dog in the shallow ditch behind the factory, with a large shard of glass projecting from its bloated side. Tucked under the collar was hand-printed note that simply said *"I win"*

## SUSPECTS:

**Shad Smudge:** Shad is 37 years old and the oldest son of Vlad. He enjoys organic gardening, and focuses most of his attention on monosaccharide type fruits. In fact, he attended a seminar on organic gardening at University of Florida June 8<sup>th</sup> to the 14<sup>th</sup>. He cooks a vegan dinner for the family every Sunday and Tuesday. Shad uses polystyrene peanuts in a cardboard box to pack his optic lenses. Shad has type A blood

**Chad Smudge:** Chad is 32 years old. Chad has always been the athlete and was the High School star Quarterback, earning him a full scholarship at OSU which was revoked when he tested positive for steroid juicing, forcing him to accept a scholarship offer from an undisclosed University north of Ohio. The week of June 15<sup>th</sup> to the 21<sup>st</sup> he volunteered at a University of Michigan Pee Wee Football Camp for incoming college freshman. Although he no longer takes steroids, he takes about every OTC drug available from antacids to foot powders. Chad wraps the glass from his line in a low density polyethylene film, then in a polycarbonate case. He fixes the family a chicken dinner every Monday and Wednesday. Chad has type B blood

**Thad Smudge:** Thad is 28 years old. He is the outdoorsman of the group, He supplies the family with all of the venison, rabbit, and turkey they care to eat, and can field dress any kill faster than a professional butcher, but has become increasingly concerned over what effect the prolific use of fertilizers may be having on the game located on his hunting grounds, next to their factory. He was going to take the week of June 1<sup>st</sup> to June 7<sup>th</sup> off to scout some new Canadian hunting grounds for a trip next fall, but due to his father's heart attack, he delayed his trip for 4 days, and took the 5<sup>th</sup> to the 11<sup>th</sup> off instead. The glass from his manufacturing line is ground into convex optic lenses and installed in Poly Vinyl Chloride tube housings used for chromatic telescopes. He fixes the family a rabbit with thickened orange juice glaze for dinner every Thursday and Friday. Thad has type AB blood

**Brad Smudge:** Brad is the baby of the clan at 24 years old. He recently completed his degree in metallurgy, specializing in sculpting that required brazing small pieces of aluminum together with a special flux. Brad manages the most basic of the glass lines and ships sheets of his glass on pallets covered on top and bottom with Polymethylmethacrylate. As the youngest brother, he is the one that gets stuck attending all of the glass trade shows and symposiums. His most recent trip was June 19<sup>th</sup> through the 22<sup>nd</sup> in "The Glass City," Toledo, Ohio. He is responsible for Saturday night dinners, but usually stops at the local Chinese restaurant and brings home some egg rolls and General Tsao's Chicken. Brad has type O blood.

**EVIDENCE:**

Upon further examination, several key pieces of evidence were found on, next to, and under the corpse and summarized as:

- ❑ Evidence 1 – Trace White Powder found in the soil around the corpse
- ❑ Evidence 2 – Trace White Powder found in the mouth and digestion tract of the “Victim”
- ❑ Evidence 3 – White Powder found sprinkled liberally over the “Victim”
- ❑ Evidence 4 – Trace White Powder found on the front seat of Shad’s car
- ❑ Evidence 5 – Polymer found around the “Victim’s” neck
- ❑ Evidence 6 – Polymer found 30 feet from the ‘Victim”
- ❑ Evidence 7 – Polymer found on the driver’s floor of Shad’s car
- ❑ Evidence 8 – Polymer found on the driver’s floor of Chad’s car
- ❑ Evidence 9 – Polymer found on the driver’s floor of Thad’s truck
- ❑ Evidence 10 – Polymer found in the trunk of Brad’s car
- ❑ Evidence 11 - Triangular shaped fiber found around the “Victim’s” neck
- ❑ Evidence 12 – Ink sample taken from Shad’s pen
- ❑ Evidence 13 – Ink sample taken from Chad’s pen
- ❑ Evidence 14 – Ink sample taken from Thad’s pen
- ❑ Evidence 15 – Ink sample taken from Brad’s pen
- ❑ Evidence 16 – Ink sample taken from the note found on the “Victim”
- ❑ Evidence 17 - Partial Fingerprint found on the shard of glass used to stab the “Victim”
- ❑ Evidence 18 - Glass analysis based on refractive results
- ❑ Evidence 19 - Entomological analysis of the corpse
- ❑ Evidence 20 - Analysis of blood found on the grasped end of the shard of glass

## Qualitative Analysis:

### PART 3.a- Chemical Analysis (10 Points Each – 40 possible)

Using the Bunsen Burners and Chemical Indicators, Identify the following Powders:

- Evidence 1     Calcium Nitrate or  $\text{Ca}(\text{NO}_3)_2$  (from fertilizer washed into the ditch)
- Evidence 2     Cornstarch (Used to thicken the gravy from Brutus's last meal)
- Evidence 3     Boric Acid or  $\text{H}_3\text{BO}_3$  (Dumped over the carcass to speed decomposition)
- Evidence 4     Glucose (From Shad's organic fruit)

### PART 3.b- Polymer / Fiber Analysis (5 Points Each – 35 Points Possible)

Using the communal density liquids located at the front of the room, identify the following Polymers:

- Evidence 5     PVC – Dog Collar
- Evidence 6     PETE- Possibly litter such as a 1 liter water or pop bottle
- Evidence 7     PS – From packing Peanuts
- Evidence 8     LDPE – From Packing
- Evidence 9     PVC – From telescope tubes
- Evidence 10    PMMA – From Packing

Identify the following Fiber:

- Evidence 11    Cotton – From handkerchief tied around Brutus's neck

**PART 3.c- Chromatography (30 Points Possible)**

Create a solution of 50% water and 50% Alcohol (70%) to use as an eluting solution, making sure that the labels stay intact. Make sure that each test is given the same amount of time. At the end of test, mark the leading edge of the eluting solution with your pen to document your findings after evaporation, then calculate the Rf values and enter them below. Tape your completed chromatograms here:

EVIDENCE 12 Shad's Pen	EVIDENCE 13 Chad's Pen	EVIDENCE 14 Thad's Pen	EVIDENCE 15 Brad's pen	EVIDENCE 16 (NOTE)
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Calculate the Rf values of each:

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Which pen was used to write the note? Explain why you arrived at that conclusion

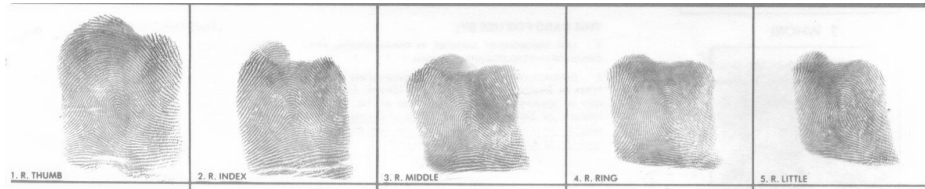
All Pens came from the same Office Supply Cabinet, so they should yield the same results

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**PHYSICAL EVIDENCE**  
**PART 3.d.i – Fingerprints (10 Points)**



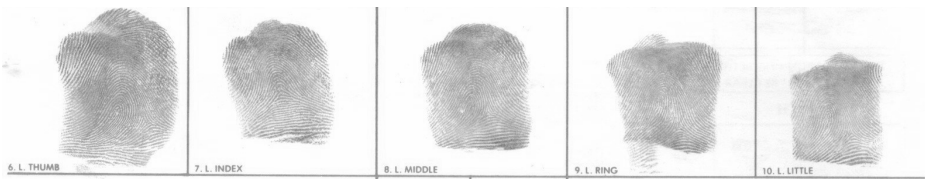
Shads Prints



Chads Prints



Thads Prints



Brads Prints



EVIDENCE 17

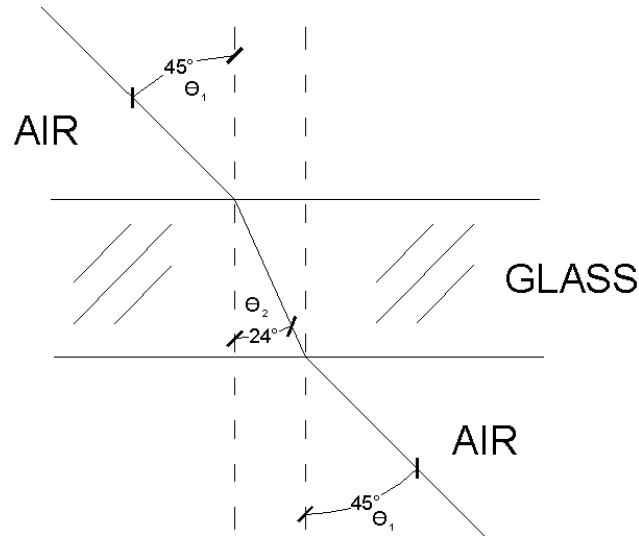
Partial Print recovered from glass shard

Which Suspect matches the partial print?

Thad

**PART 3.d.iii – Glass Refraction (10 Points)**

Evidence 18 was the shard of glass removed from the Victim. It was carefully removed, cleaned, and analyzed. The refractive tendencies of the glass are listed below:



Using the above data, calculate the Index of Refraction below. Show the formula used as well as a legend that defines the variables of your equations

**Snell's law:  $n_1 \sin \theta_1 = n_2 \sin \theta_2$**

**Where  $\theta_1$  = Angle of Incidence = 45 degrees: Sine of 45 degrees = .7071**

**$\theta_2$  = Angle of Refraction = 24 degrees: Sine of 24 degrees = .4067**

**$.7071 / .4067 = 1.738628$  Index of Refraction**

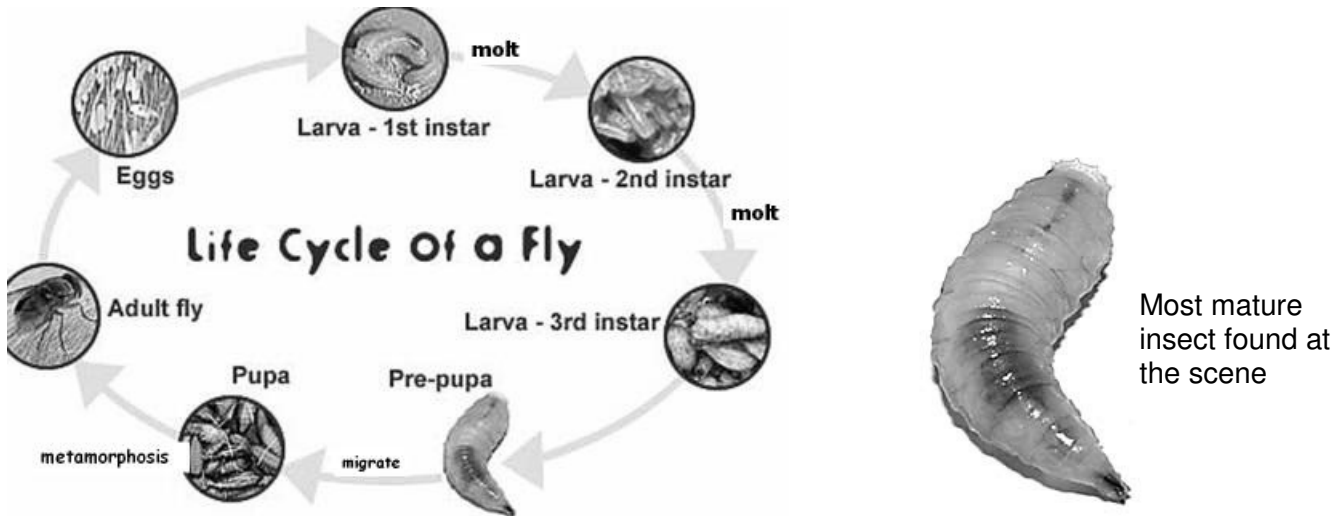
<b>Son</b>	<b>Type of Glass</b>	<b>Index of Refraction</b>
<b>Shad</b>	<b>Arsenic Trisulfide Glass</b>	<b>2.04</b>
<b>Chad</b>	<b>Lanthanum Flint Glass</b>	<b>1.87</b>
<b>Thad</b>	<b>Extra-Dense Flint Glass EDF-3</b>	<b>1.72</b>
<b>Brad</b>	<b>Standard Flint Glass</b>	<b>1.6</b>

**Based on the above chart, it appears that the glass that killed Brutus came from Thad's manufacturing line**

Comparing your results to the data on page 1 of this Scenario, which type of glass was the shard made from?

**PART 3.d.iv – Entomology (10 Points)**

Evidence 19 was insects collected from the corpse. The local Entomologist has identified these as various stages of the same insect – the Blow Fly. After careful examination, it appears that every stage of the lifecycle was found at the scene except the pupa stage. Even the surrounding area was examined. It was as if none of the eggs had reached that maturity yet. The adult flies that were found were examined and found to be in excess of 4 months old and the source of the non-mobile stages found



A quick check with the local weatherman provided the average temperature for the month of June as 70 degrees Fahrenheit. Using the most mature site generated life stage of the flies found at the scene, and converting this temperature to Celsius using the formula “(F-32) x 5 / 9 = C,” then referencing the chart below should provide a reasonably accurate time of death.

Temp(°C)	Egg Larva (hours)	1st Instar (hours)	2nd Instar (hours)	3rd Instar (hours)	Pre-Pupa (hours)	Pupa (hours)	Total Time (Days)
16	41	53	42	98	148	393	32
21	21	31	26	50	118	240	20
27	18	20	12	40	90	168	14

**Calculations:**  
 70 degrees F – 32 = 38 x 5/9 = 21.1111 degrees C

**Since no Pupae were found at the scene, we can assume that stage of the lifecycle has not yet been reached. Adding up the hours to reach the Pre-Pupa stage we get: 21+31+26+50+118 = 246 hours / 24 = 10.25 days**

**Backing up 10 days from the day the carcass was discovered, we find that the day of death was most likely Friday the 13<sup>th</sup> ... a VERY unlucky day for Brutus!**

Based on the above information, the date of death was most likely how many days prior to the date of Discovery?

### **PART 3.d.viii – Serology (10 Points)**

Using the Serology plate provided, carefully approach the unnamed suspect in the corner of the room and collect 2 drops of his blood. Now take it to the Nurse and ask for a drop of A and B testing solution. Mix thoroughly with toothpick provided. An agglutination reaction may take up to 3 minutes.

A positive agglutination reaction would indicate the presence of those antigens and a lack of those antibodies. Be advised that as in a real lab setting, the reaction to type B antigens (if any) is much more subdued than the type A reaction, so watch closely.

A positive reaction to both solutions could indicate either an AB blood type or a mixture of blood from at least two individuals with A and B blood. Since type O blood provides a negative reaction to both solutions, the remote possibility always exists that that it may also be mixed in with either of the above scenarios. Further analysis under an electron microscope can determine if the sample is from more than one person, but in this test, it can prove exclusionary to types A, B, and AB only with negative results.

Based on this level of testing, list the possible suspect or groups of suspects if sample was mixed

***Sample Tested as AB type.***

***Thad has type AB Blood, so he is the most likely Suspect, but at this level of testing other scenarios may also exist:***

***Shad has type A blood, Chad has type B blood. If both were cut by the shard, then mixed equally, a positive result from both tests would be possible at this level.***

***Brad has type O blood which would yield a negative result from either test, but if mixed with Thad's blood, may be masked by his positive results***

***Brad also may have conspired with the Shad and Chad combination, with all 3 blood types mixed on the handle end of the shard***

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**PART 3.e – Analysis of the Crime (60 Points Possible)**

On the Calendar below, note the following:

- Date of Corpse Discovery
- Date of Death, based on Entomological Data
- Potential Alibi dates of each of the sons,

<b>June 2008</b> Average Temperature 70 degrees F						
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6	7
				Thad's Scouting Trip	→	
8	9	10	11	12	13	14
Shad's Organic Gardening Seminar	→				Death Day	→
15	16	17	18	19	20	21
Chad's youth football camp	→		Brad- Glass Show in Toledo	→		
22	23	24	25	26	27	28
	Dead Dog Found - beginning to pupate					
29	30					

Now, tie it all together with a written essay not to exceed this page, front only.

***Evidence 1 was Calcium Nitrate, a common ingredient in commercial fertilizers. This chemical is extremely soluble, and was likely dissolved in the spring storm run-off, and deposited in the ditch when the rain water evaporated. Thad was concerned about over fertilization of his local hunting grounds***

***Evidence 2 was cornstarch ingested by Brutus, most likely as thickening to the orange glaze that Thad fixed on Friday the 13th.***

***Evidence 3 was Boric Acid, probably poured over the carcass to speed up the decomposition.***

***Evidence 4 was Glucose found on the front seat of Shad's car, possibly coming from evaporated fruit juice.***

***Evidence 5 was a PVC dog collar***

***Evidence 6 was a PETE drink bottle littering the ditch***

***Evidence 7, 8, 9, 10 were PS, LDPE, PVC, and PMMA, all of which are used in packing the glass and unremarkable***

***Evidence 11 was one of the cute little handkerchiefs they tie around overly pampered pooches***

***Evidence 12, 13, 14, 15, and 16 were ink samples from the 4 boys' pens, and the note. Unfortunately, all of the boys get their pens from the same supply closet, so they all match. Send the note on to the handwriting expert – maybe they can identify a suspect.***

***Evidence 17 was a smudged, poorly degraded partial fingerprint found on the glass shard. Although not definitive, it looks like it may belong the Thad.***

***Evidence 18 was the actual glass shard, identified as EDF-3, Extra Dense Flint Glass by the Index of Refraction. This clearly implicates Thad***

***Evidence 19 was the fly larva that identifies the time of death as Friday the 13<sup>th</sup>. Although this does not implicate anyone, it does provide an alibi for Shad, since he was at the Gardening Seminar at that time. Since Shad could not have done it, his blood could not have been on the shard, leaving only Chad's type B blood viable. Since the blood found was AB, it has to have come from Thad as well.***

***Based on the above analysis, the most likely Suspect would be Thad Smudge.***