University of Texas at Austin

Virtual Invitational 2020

Forensics

Division C

TEST PACKET

School/Team Name _____

Team Number_____ **Name(s)**_____

Instructions:

Hi everyone and welcome to Forensics! Please make sure to read through the crime scene setup and through all parts of the test before attempting any questions. Please also make sure to read the questions to completion as there may be additional criminal or background information embedded within the questions.

Because we have so many teams testing and grading capability is limited, most of the questions will tell you how to format your answer (include only the abbreviation or letter code, e.g). If your answer is not in the desired format, we will award you no points at all for that question, whether it was right or wrong.

Finally, please do NOT google any of the questions or otherwise utilize the Internet to search up information or the answer to a particular question; it's particularly difficult to maintain testing integrity due to the extended nature of the test as well as the structure of some of the questions, so we ask that you not take advantage of the unconventional testing adjustments.

Have fun!

Scenario:

After years of being on the run, Peter Burke has finally tracked his former partner and conman Neal Caffrey through dozens of European cities to a startlingly unusual location: Neal is now on American soil, in Austin, Texas. After making remote contact with Neal, Peter learns that Neal is under pressure by a third party to recover something from UT Austin's Blanton Museum of Art, but the Bolivian fabric sculpture he was planning to steal had already been taken by someone else. Peter is distrustful, but decides to believe Neal, asking, "Then who could have done this, Neal?"

"All I know is that when I went to scope out the sculpture *recently*, the sculpture on display was clearly a forgery, with shape lines inconsistent with that of Valdés' work during that time period," Neal replied.

"And that's all you know for certain? Neal?"

"Okay, at that point, someone passed me a message saying 'Good luck delivering now. This is for the charges...'"

Peter and Neal have now come to the conclusion that their main suspects must be someone they've (tried to) put someone away in the past. After a night-long conversation, they come up with the following short-list:

1. **Vincent Adler:** An eccentric conman who the FBI finally put away for his conspiracy to steal Nazi treasure, Adler used to be Neal's former boss until he pulled off a large Ponzi scheme and Neal was left with nothing. Adler was thought to be dead when he threatened Neal's life and Peter shot him, but new intel arises he may have survived and he's back for revenge.
    a. Blood type: AB-
    b. Pets: None
    c. Hair Color: Reddish-brown
    d. Attire: dusty gray linen suit, with a couple of motor oil stains
    e. Other: Carries hot packs often since he is sensitive to the winter cold. He also loves coming to Austin and visiting the bat colonies that parts of the city are famous for. He claims he doesn't like Neal enough to be wasting his time on "petty paybacks." He seemed to be in a rush however; the water filter in his house broke and they were coming to fix it the day of questioning, and he is "sick and tired of drinking out of bottles."

2. **Dr. Mara Summers:** Possibly one of the more scarier antagonists on the show, Dr. Summers is a professor of psychology who worked with convicted ex-cons and conspired to mentally trick them into robbing banks, and even gets into Neal's inner conscious once and tells him he can never reform from his sneaky methods. Being put away, she's been waiting to play mind games with Neal. Since being released, she now teaches as a professor at UT.
    a. Blood type: B-
    b. Pets: None
    c. Hair Color: Brown
    d. Attire: Her usual silk neck scarf and cerise woolen dress.
    e. Other: Has a fear of squirrels after being attacked by the campus rodents numerous times (she had a bag of walnuts with her). She also developed migraines over the years, and regularly takes meds in an attempt to alleviate her headaches. She also said she had left the past behind a long time ago, as she no longer found it fun or amusing.

3. **Henry Dobbs:** Also known as Robert Macleish, one of FBI's Most Wanted Fugitives, Henry originally owned the island Neal and Mozzie fled to and then later couldn't escape. He's a man with rich taste and is usually a "go-lucky guy" as others would describe him, except he has been holding a grudge against Peter and Neal ever since they crashed his house-warming party and tried to arrest him. The fiasco caused panic and a dent in Dobbs' record in the criminal world, a reputation he had worked hard for.
    a. Blood type: AB+
    b. Pets: owns a ranch offshore
    c. Hair Color: light brown

    d. Attire: Loves Hawaiian polyester shirts
    e. Other: Has been suffering from heart burns and is taking anti-acid medications for it. Has recently also taken up 3D printing as a hobby to make more boats in bottles.

4. **Alex Hunter:** Alex is one of Neal's allies though she's double crossed him quite a few times. Though it seems like they left on good terms, she can be volatile and there's a good chance she'd place their friendship second to any large swindles or scores. However, stealing and gambling with relics was her muse only when Neal was involved in the game; otherwise, she claimed to have grown bored of the chase and has moved on to other things. Maybe having Neal involved again has changed that ...?
    a. Blood type: A+
    b. Pets: A cat
    c. Hair Color: Brown
    d. Attire: Polyester open-back dress
    e. Other: Alex has been prioritizing self-care after many years of running and hiding. She enjoys eating sugary foods as a destressor, particularly macarons. She also loves to garden and spends most of her time outside tending to her tulips - her favorite.

5. **James Bennett:** Neal's long lost father and fugitive who goes on the run after killing a senator who he posited was framing him. It's evident he'll prioritize his own liberties over anything too.
    a. Blood type: A-
    b. Pets: Technically none, but enjoys going horseback riding at the local stable.
    c. Hair Color: originally brown but now gray/white
    d. Attire: flannel and rough jeans
    e. Other: He is rather embarrassed about his acne and has been staying in to avoid being seen. Only recently he started using new acne medication when leaving the house, only to get Chinese takeout too often a week.

At this point, Peter comes to Austin with his trusted colleagues, Diana and Jones, along with Mozzie, to help Neal break into the Museum and recover any forensic evidence from the forgery/surrounding exhibit. Here's what they found:

- Exhibit A and B (powders) found at the scene
- Plastics A-E
- Fibers A-D
- Ink sample from note
- Mystery compound at scene
- Fingerprints A-C
- Glass
- DNA
- Blood sample on glass

A. Powders

Mozzie was able to recover 8 unusual powders from the exhibit, but senses they may have been contaminated due to the delay in getting samples. Thus, he tells you that **7** of these properties are erroneous, but that you should be able to nonetheless recover the identities (since, at most one property per row is erroneous). Some powders may appear more than once.

Powder	Reaction with Benedict's **(A)**	Flame Test **(B)**	Reaction with NaOH **(C)**	Reaction with HCl **(D)**	Crystalline shape **(E)**	pH **(F)**
Evidence A	N	Red	N	N	Monoclinic (trihydrate)	8-9
Evidence B	N	Boils off hydration	N	N	Triclinic (pentahydrate)	~10
Powder C	Orange	Boils off hydration	N	N	monoclinic	6-7
Powder D	N	Green	Y	N	triclinic	5-6
Powder E	N	Boils off hydration	N	Y	Triclinic	~6
Powder F	N	Purple	Y	Y	circular	7
Powder G	Brown	Orange	N	N	cubic	7
Powder H	N	Yellow	N	N	anhydrous	8-9

1. Identify the powders. Provide the full name (1 pt) and chemical formula (1 pt):
    a. Evidence A:
    b. Evidence B:
    c. Powder C:
    d. Powder D:
    e. Powder E:
    f. Powder F:
    g. Powder G:
    h. Powder H:

2. Identify the seven errors by putting the column letter (A-F) in which there's an error. There can be none! (1 pt each, explanation not required)
    a. Evidence A:
    b. Evidence B:

c. Powder C:
d. Powder D:
e. Powder E:
f. Powder F:
g. Powder G:
h. Powder H:

3. Relate each of the powders to their suspect(s), if any, and describe how they were used (suspect = 1 pt, use = 1 pt):
    a. Powder C:
    b. Powder D:
    c. Powder E:
    d. Powder F:
    e. Powder G:
    f. Powder H:

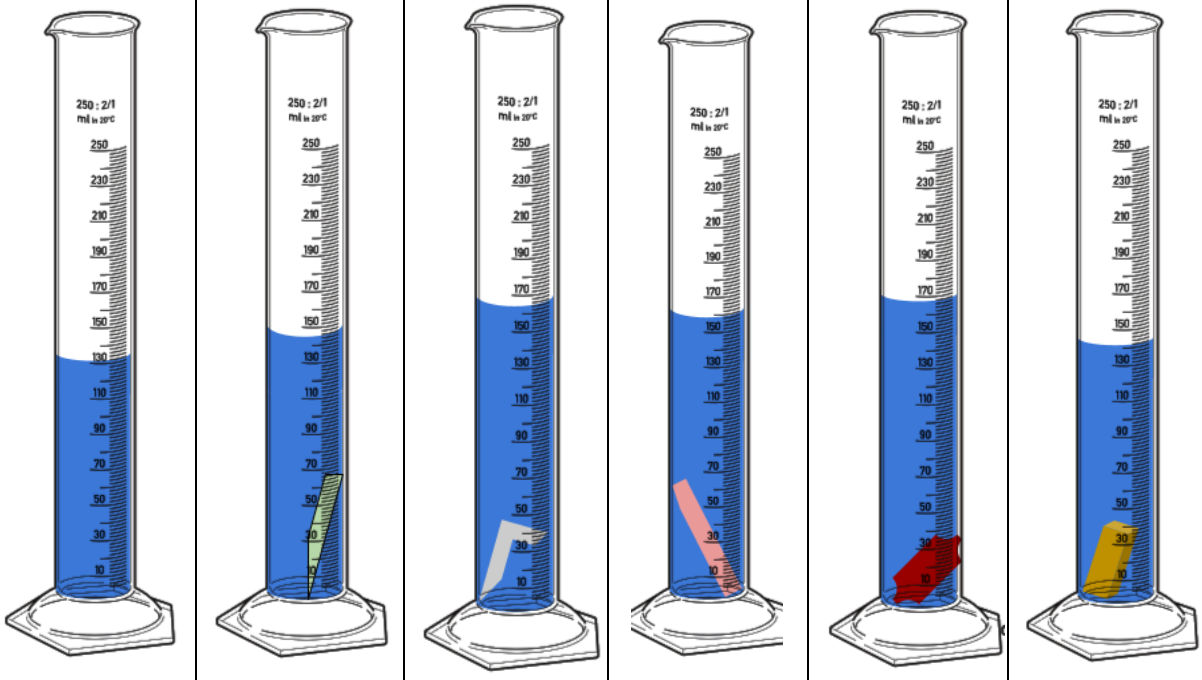
4. Based on your answers in #3, which suspect(s) do Evidence A and B incriminate? How were the powders used? (suspect = 1 pt, use = 1 pt)
    a. Evidence A:
    b. Evidence B:

B. Polymers (Plastics & Fibers)

In addition to some of the fibers that made up the sculpture, Diana also found some plastics and fibers in the exhibit.

Plastics:

Diana finds 5 plastics, one of which was likely used in the making of the sculpture. Two of these plastics (A, B) were found near the sculpture while three (C-E) were found slightly further away. Since the samples are large enough, you decide to run flame and water displacement tests to determine what the identity of each plastic might be. For each plastic, determine its identity.

Starting water level:	**Plastic A:**	**Plastic B:**	**Plastic C:**	**Plastic D:**	**Plastic E:**
					
mass of tested plastic >	20.7g	46.92g	29.40g	35.89g	15.18g
flame test >	yellow	greenish-yellow	yellow	Bluish, yellow tip	Yellow, green

1. Identify the 5 plastics (give abbreviation ONLY) (2 pt each):
    a. A:
    b. B:
    c. C:
    d. D:
    e. E:

2. Which plastic(s) do you think came from the structure of the sculpture? No explanation needed, only list the plastic codes separated by a comma (e.g. A, B, C) [2 pt]

3. For each of the following plastics, fill in the blanks [1 pt per entry] :
    a. Plastic A likely incriminates _____because_____.
    b. Plastic B likely incriminates _____because_____.
    c. Plastic C likely incriminates _____because_____.
    d. Plastic D likely incriminates _____because_____.
    e. Plastic E likely incriminates _____because_____.

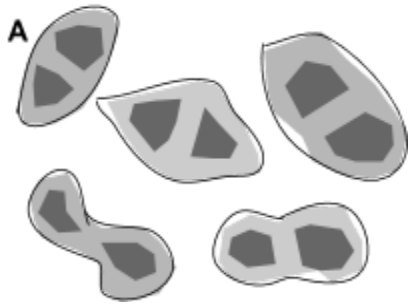
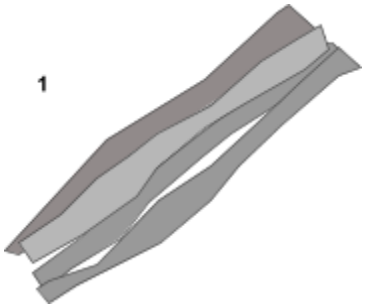
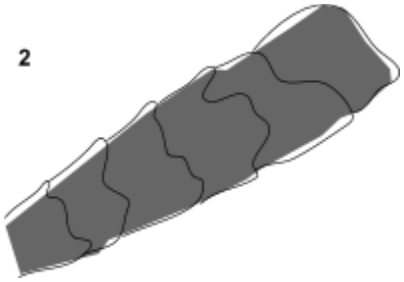
4. As you do the burn tests, you realize you've actually added too much heat to the plastics and their chemical structure/makeup may have changed. Did any plastics char? If so, which ones (list sample letters)? [2 pt]

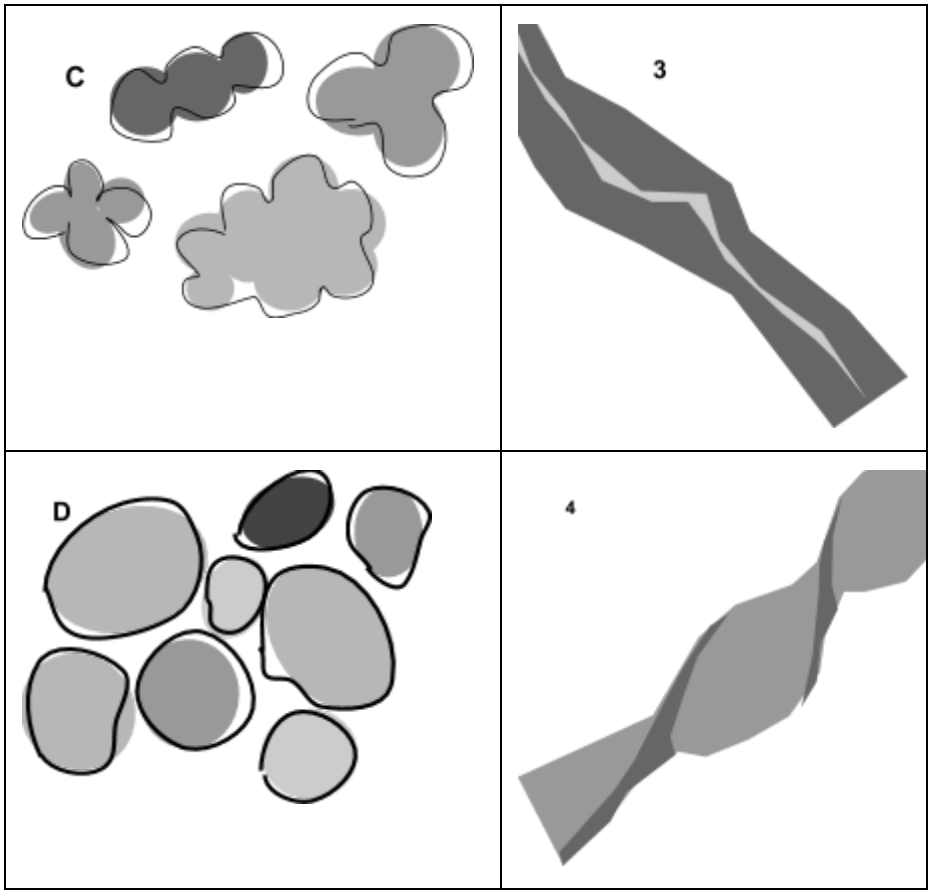
5. If a plastic chars, what kind of plastic is it? [1 pt]

Fibers:

Diana finds 4 fibers, but thinks it's possible that some of the fibers came from the sculpture, which was made out of sateen and gabardine.

1. Match the cross sections of the different fibers to their view under the microscope (1 pt each):

Cross Section	Longitudinal View
	
	



2. Identify the fiber presented in ... (1 pt each)
    a. Cross Section A:
    b. Cross Section B:
    c. Cross Section C:
    d. Cross Section D:

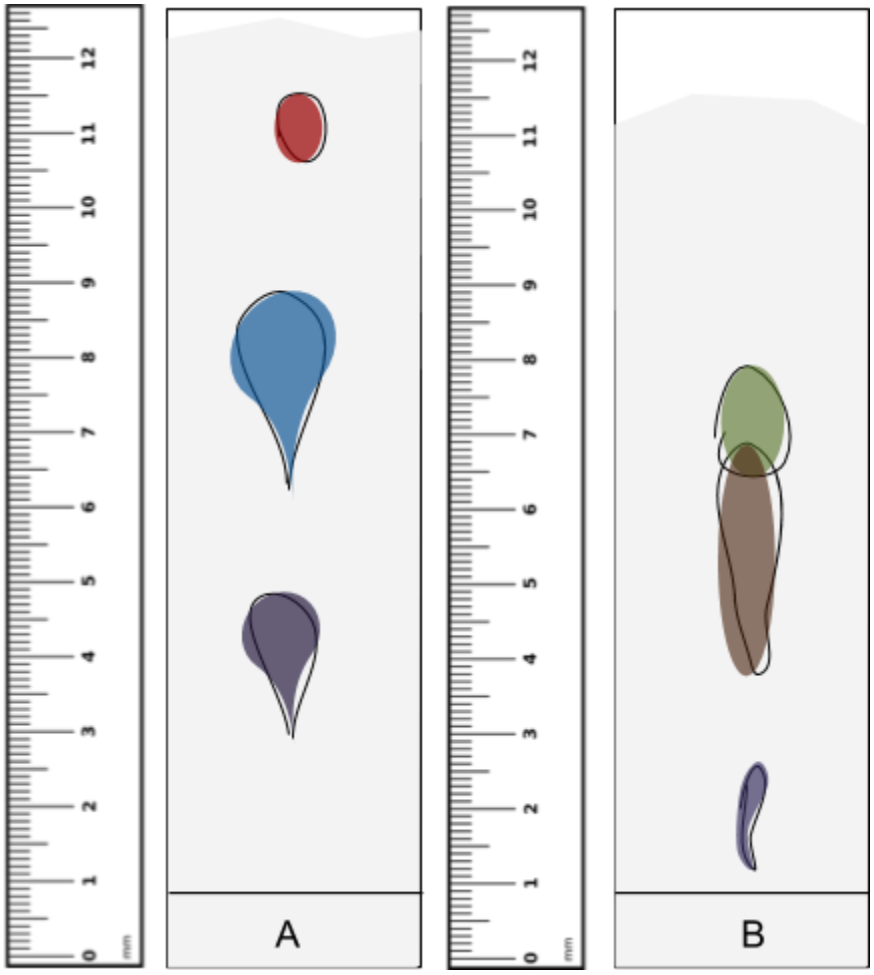
3. What main fiber is involved in the making of sateen? (1 pt)

4. What main fiber is involved in the making of gabardine? (1 pt)

5. Based on the above information, which fibers appear to be incriminating, and who does each one incriminate? [1 pt per entry]
    a. Fiber/Cross Section A appears to incriminate _____ because _____.
    b. Fiber/Cross Section B appears to incriminate _____ because _____.
    c. Fiber/Cross Section C appears to incriminate _____ because _____.
    d. Fiber/Cross Section D appears to incriminate_____ because _____.

C. Chromatography

From inspection of the note Neal found, it looks like there are two different types of running/bleeding in the ink, suggesting that two different inks/pens were used. Answer the questions about these two chromatograms below, with rulers provided for your convenience:

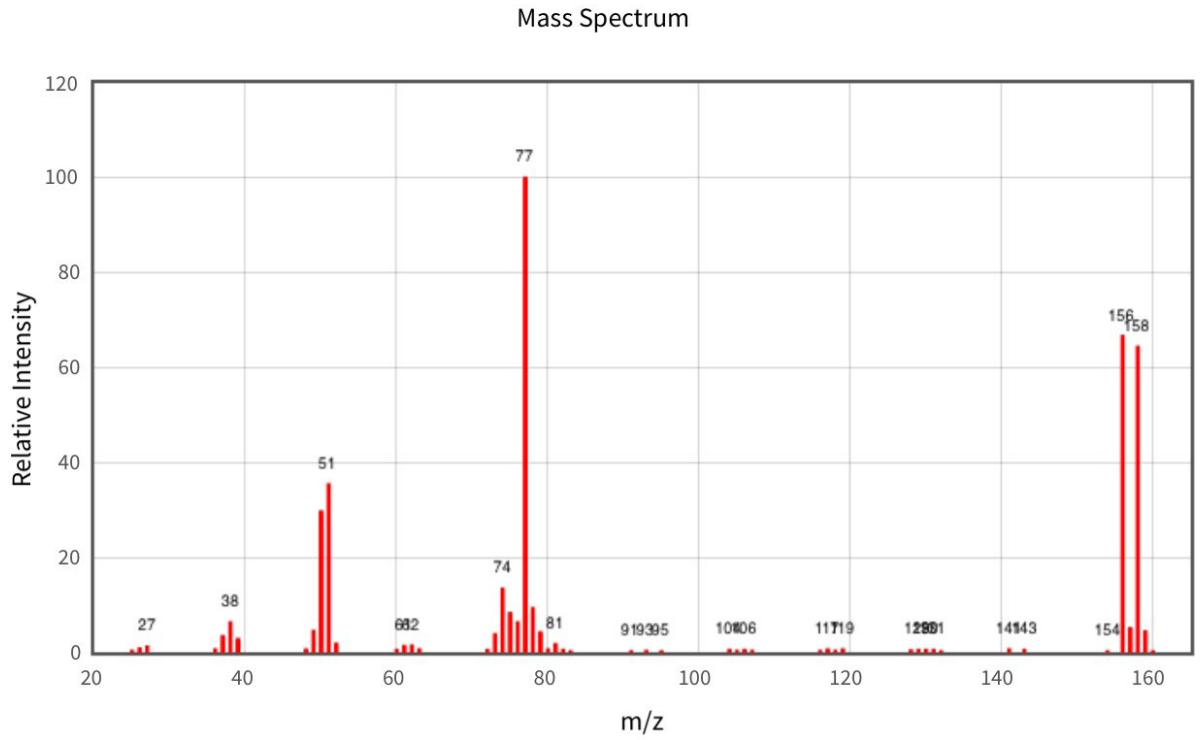


1. To two decimal places, calculate the Rf of all 6 spots on both chromatograms. (need to give +- 0.05) [0.5 pt each]
    a. A:
        i. Red: _____
        ii. Blue: _____
        iii. Purple: _____
    b. B:
        i. Green: _____
        ii. Brown: _____
        iii. Purple: _____

2. Pens are collected from 3 of the suspects: Mara Summers, Alex Hunter, and Henry Dobbs. Mara's pen had an Rf of 0.34, Alex's pen had an Rf of 0.70, and Henry's pen had an Rf of 0.80. Even though these might not be comprehensive Rfs, which pens might match up most to either of the A/B ink samples? [2 pt]

D. Mass Spectrometry

Peter notices a sweet smell coming from what seems to be a bit of clear liquid on the ground. Taking a sample of this, he decides to run it through UT's mass spectrometer and asks for your help in deciphering the data. Here is the plot:



1. What is the molecular weight of this compound? [1 pt]

2. There seem to be 5 intermittent bits (at roughly 91, 103, 117, 129, 141 are the intermittent fragments, completion at ~153) that suggest there's one atom or fragment of the same mass that keeps getting added to form the larger product. What atom is this? [2 pt]

3. How many of those atoms are in the compound? [1pt]

4. Based on the sweet smell, you think you have an aromatic compound of some kind. Using this information, what kind of fragment is present at the M peak? Write its chemical formula, with overall charge if any at the end. [3 pt]

5. We now have one of the main fragments! Based on the lack of fragmentation between the M peak and M+1/M+2 peaks, we think it might be safe to assume only one additional atom might be added to the structure. What atom is this? [2 pt]

6. Put everything together! What is the chemical formula of this compound: [3 pt]

7. Mozzie pointedly notes that acetates with that kind of sweet smell usually show up in industrial pesticides while benzylic compounds are really common in motor oil and gasoline. Where did this compound originate?[1 pt]

E. Fingerprints

You tag along with Mozzie to the exhibit to help him pick up some fingerprints to analyze. Neal suggests that the ideal break-in route would have been through the service entrance, a door with a simple exit metal push bar. Then, the culprit would have to remove some greasy screws from underneath the sculpture's stand to unfasten it, remove the sculpture, and escape going through the alley exit on the bottom floor, where the thief might have brushed up against a new layer of paint that hadn't dried yet.

1. Pick one valid option of picking up fingerprints for each of these three locations:

Location	Options (2 pts each)
Metal push bar, service door	a. Dusting b. Peroxidase-reaction chemicals/phenolphthalein c. Silver nitrate
Greasy underside/screws of stand	a. Ninhydrin b. Cyanoacrylate c. Sudan Black
Layer of paint, undried	a. Kastle-Meyer Test b. Small particle reagent c. Ninhydrin

2. Prints A-C were collected from the crime scene using the above specified methods. Further analysis revealed that the prints were from the left hand, so prints of the suspects' left hands were taken as well. Identify each fingerprint (be as specific as possible):

Source	Print	Type of Print (1 pt)
Print A - Crime Scene		
Print B - Crime Scene		
Print C - Crime Scene		
Print D - Henry Dobbs		

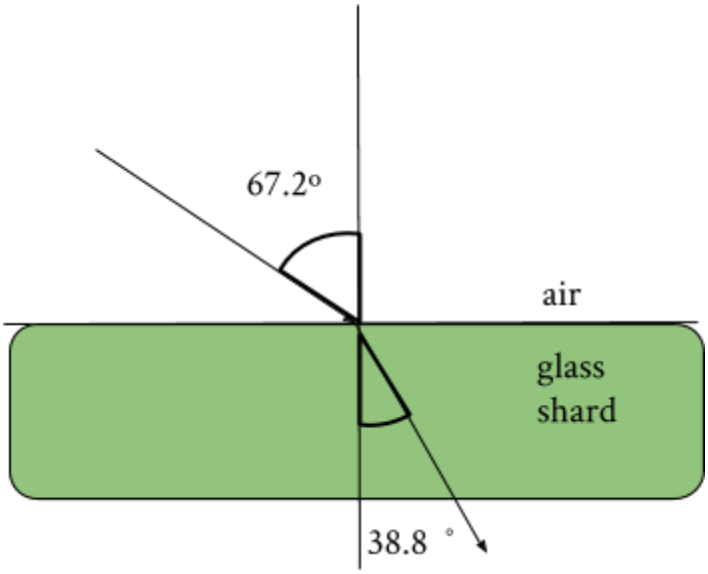
Print E - Vincent Adler		
Print F - Alex Hunter		
Print G - Dr. Mara Summers		
Print H - James Bennett		

3. Who do Prints A and B incriminate, if anyone? [3 pt, 1 pt per print]
    a. Print A:
    b. Print B:
    c. Print C:

F. Glass:

Neal shows Jones some samples of glass shards he found where the exhibit had lay, noting how weird this was given the fact that that the sculpture was purely made of plastic trusses and fabric. Jones notes there had been some unusual crimes around the city, with no suspects so far in any of the three cases:

1. Some plants were stolen from the local garden; the breakin occurred on the south side of the garden's greenhouse, and it's possible that toxic chemicals could be extracted from the plants that were stolen.
2. A stolen car found by the university, with some tail lights broken
3. Two blocks from the museum, a residential house has its sliding doors broken after someone forcibly entered their home for what appears to be a quick steal.



1. Calculate the index of refraction. (2pts)
2. What is the speed of light through the glass shard's medium? (1pt)
3. Based on where this glass type might be used, where do you think we could place the criminal: (2 pts)
    - By the car burglary
    - The greenhouse
    - The residential house

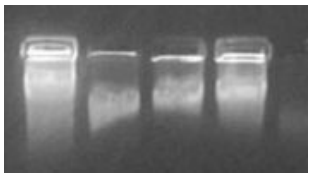
G. DNA

It turns out that this crime is connected to other similar crimes that have occured recently. Jones visited the previous crime scene (as chosen in the Glass section) and found shards of the same type of glass at the scene, but with blood and DNA left on them.

1. What type of electrophoresis is typically used in DNA profiling (1 pt)?
    a. Polyacrylamide gel electrophoresis
    b. Capillary electrophoresis
    c. Pulsed field electrophoresis
    d. High resolution electrophoresis

2. Mozzie extracted the DNA samples from the scene and returned to the lab to perform PCR. However, during the run he decided to increase the duration of elongation, and increase the temperature during the annealing phase. How would these adjustments affect his final yield (2 pts)?
    a. Yield increased, but precision decreased
    b. Precision increased, but yield decreased
    c. Precision and yield both increased
    d. Precision and yield both decreased

3. Poor Mozzie; he also tried to run DNA electrophoresis, only to find smears in his DNA fragments' bands. Below is what he sees:



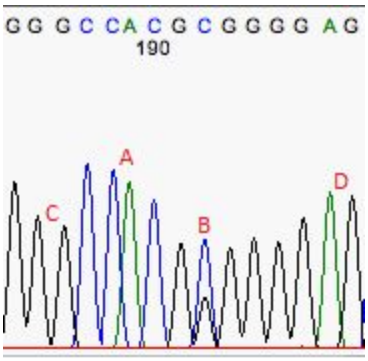
He has concluded that biochemistry techniques are not his forte. What could be the reason for the smears below the DNA bands? (1 pt)

    a. DNA began to degrade as it moved through the gel
    b. Proteins were accidentally present in the sample
    c. Contamination of RNA
    d. The voltage was too high and tried forcing DNA through the gel.

4. He was also confused that he added 4 endonucleases to digest the DNA at specific spots to produce 5 fragments, but only saw 4. What could be the reason? (2 pts)

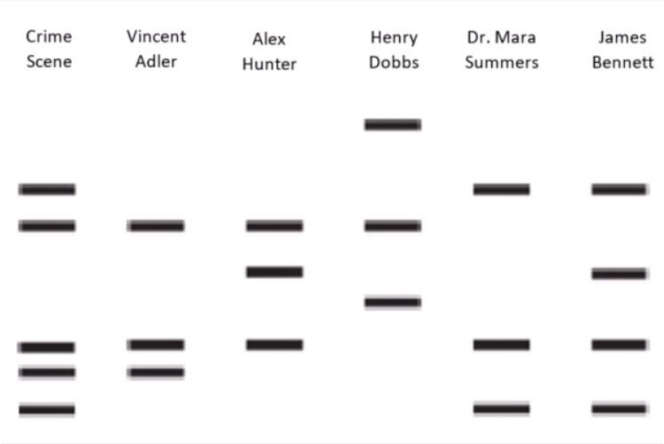
5. Give the complementary strand of RNA for the template strand of DNA listed below. (1 pt)
   3' AAACCACGGACGCGG 5' DNA template
    a. A. 3' TTTGGTGCCUCGCGG 5' mRNA
    b. B. 3' UUUGGUGCCUGCGCC 5' mRNA
    c. C. 5' TTTGGTGCCUCGCGG 3' mRNA
    d. D. 5' UUUGGUGCCUGCGCC 3' mRNA

6. In the chromatogram below, indicate the location of the heterozygous SNP (1 pt):



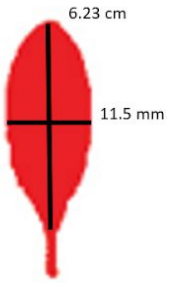
   a. A
   b. B
   c. C
   d. D

7. Based on the electrophoresis performed by someone *other* than Mozzie, which suspect(s) is incriminated, if anyone? (2 pt)



H. Blood

1. Calculate the angle of impact found on the piece of glass. Include any formulas used. (answer = 1 pt, work = 1 pt).



2. Based on where the sample was found, and the angle you've just calculated, is it possible to determine whether the blood dripped first or the glass broke first? (1 pt)

3. You decide to do some blood typing on this sample and find the following results (spotty is agglutinated, contiguous is not agglutinated):

Anti-A Anti-B Anti-Rh

What is the blood type of the sample? (1pt)

4. Who does this sample incriminate? (1 pt)
5. Is it possible for blood with a different blood type than that identified in (3) to be mixed with another blood type to produce the above results? (2 pt)

I. Analysis

Describe who Peter and Neal should pursue and which suspects are likely not to be behind the crime. Be sure to mention any auxiliary details along with any evidence that would rule out a suspect or contribute to their potential involvement.

TOTAL ANALYSIS POINTS: 85 points