

# A Sofishticated Theft



Competitor Names: \_\_\_\_\_

Team Name: \_\_\_\_\_

Team Number: \_\_\_\_\_

## Rules:

You have 60 minutes to solve the crime. Don't forget to pay attention to motives, and make sure to read the story carefully. Last but not least, have fun! :)

## 2019-2020 Forensics Test

After months of planning, Billy Bill's family finally started a long-anticipated trip to the beach. His parents, little brother, and pet bat came along, and they all piled into the family's Honda Odyssey. After fifteen hours of sleeping, munching on salt and vinegar potato chips, and eating cookies, they reached the golden sands of the beach. However, the weather was extremely rainy, so they were unable to hit the waves. Because of the inclement weather, Billy Bill's family chose to head over to the hotel and unpack their belongings first. They took half their polyester suitcases upstairs to their room after checking in, and were downstairs getting the other half when Billy Bill noticed something alarming.

"Oh my gosh, our suitcases are empty! I knew I wasn't strong enough to carry two whole suitcases by myself!"

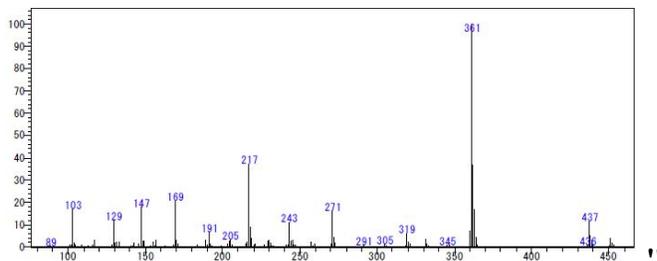
Someone had picked the locks, disappeared with the family's belongings, and only left a note that read, "Y'all are suckers, watch your stuff better next time". The hotel staff was immediately notified of the crime, and the police quickly rushed to the scene. Unfortunately, the security cameras were currently in maintenance and did not record anything useful. However, an old woman walking by reported that she saw someone run out of the hotel and into a car while clutching a full garbage bag not too long ago. She was unable to name the model, but fortunately the police were able to recover tracks that had not been washed away by the rain.

A set of muddy footprints were recovered from the scene that were tracked all around the suitcases. The mud-like soil from the footprints was also collected for analysis. A mass spec was done on the powders collected from the scene, and paper chromatography was done for the ink used to write the note. Powders, fingerprints, hair, and fibers were also collected from the crime scene. The main suspects have been determined to be the usher, the man who was rooming next to them, the desk clerk, and the security camera repairman. It's your job as the chief detective to find out who committed this theft and help the Bill family save their vacation. Good Luck!

The following is other evidence recovered from the scene:

- Powders U1 and U2 were found on note
- Fingerprints U1 and U2 were found on the suitcase zippers
- Hairs U1 and U2 were found on the suitcases
- Fibers U1 and U2 were recovered from the inside the suitcases

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## Uur geu<'

**Pco g<**Joey Joe

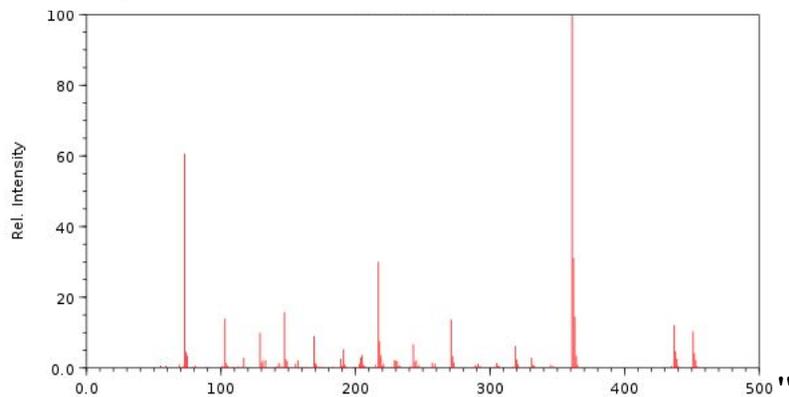
**Lqd<**Usher

**O qvkg:** Joey was annoyed that he had to bring the family's heavy luggage into the hotel by walking through the rain. Mud had also gotten on his new wool pants.

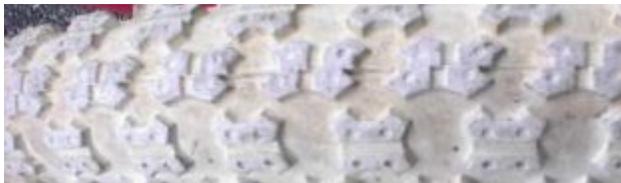
**Crdk** Joey was warming up his hands with a heat pack after getting soaked in the rain. He was also having heartburn after drinking too much coffee. After moving their suitcases into the hotel, Joey went to go help the repairman fix some of the hotel's deteriorating drywall, but not before making sure his pet bat was safely inside his pen. He also chatted with Willy Will for a bit about their pets before going to help the repairman Sammy with the walls. After coming back from fixing the walls, Joey found out about the theft.

**Gxlf gpeg<**Powders P1 and P2, Hair H1, and Fiber F1 were found on him. Joey uses Pen 3

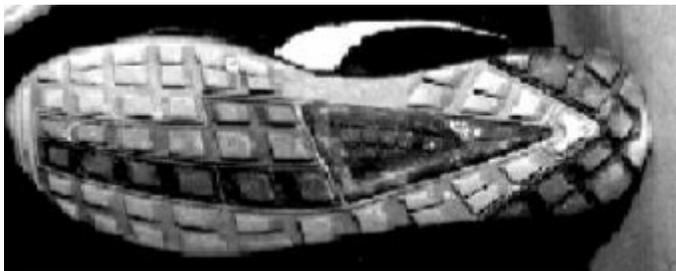
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**Pco g:** Willy Will

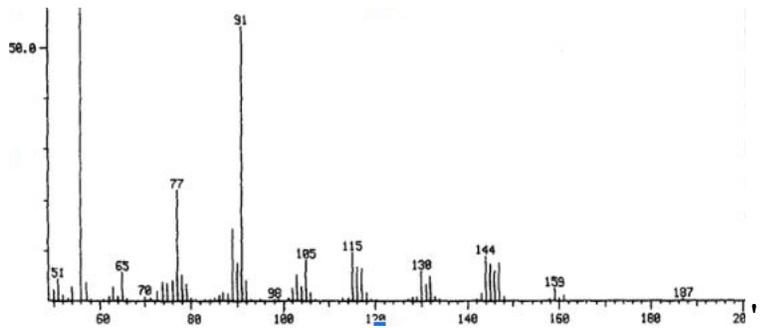
**Lqd:** Escape room manager

**O qvkg:** Willy was in the room next to the Bill family, and was annoyed that they were being so loud. Billy's little brother also stepped on his favorite polyester shoes, getting them all muddy.

**Crdk** Willy had a headache from working the entire day to clean all of the escape room lock picking kits, and was taking a bath with epsom salts to relax. He took medication for his bipolar disorder, then chatted with the Usher for a bit about their pets in the lobby before taking a walk with pet horse outside. When he got back to the hotel, he argued with the Bill family for half an hour about how loud they were before going back into his room.

**Gxlf gpeg:** Powders P3 and P4, Hair H2, and Fiber F2, Willy uses Pen 2

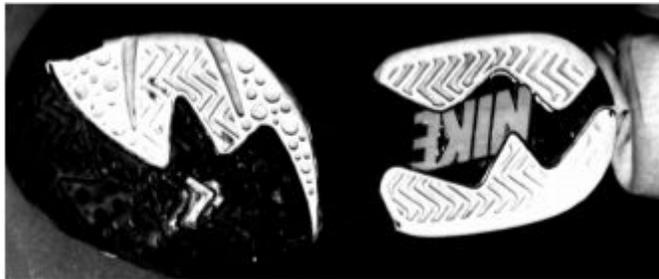
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**Pco g:** Molly Mo

**Lqd:** Hotel Clerk

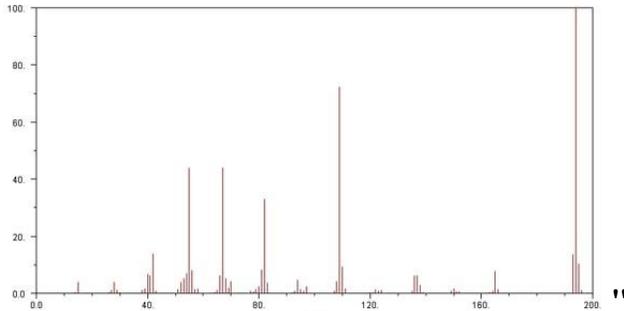
**O qvkg:** Billy's family wiped their muddy shoes all over the newly polished lobby floors, which immensely irritated Molly, who had just paid the repairman Sammy to clean them.

**Crdk** She was taking the recycling to the nearby recycling facility. She had to take her own car there because the hotel car had been invaded by squirrels. She had attempted to chase them out, but only ended up getting squirrel hair all over her cotton uniform. She has a tendency to stress

eat, and ended up eating all of the hotel's complimentary cookies after returning, as well as any leftover snacks in the kitchen.

**Gxlf gpeg:** Powders P5 and P6, Hair H3, and Fiber F3 were found on her. Molly uses Pen 1

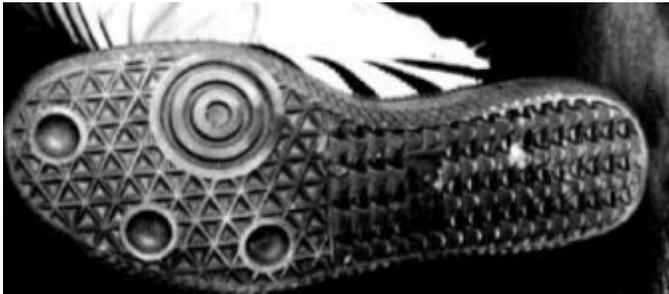
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**Pco g:** Sammy Sam

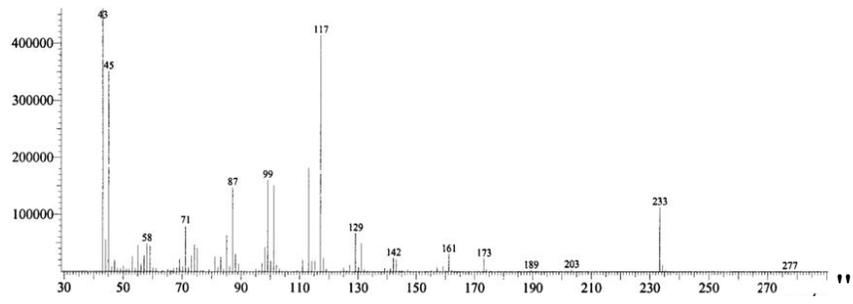
**Lqd:** Repairman

**O qvkg:** Sammy was angry that Billy's family dirtied the floors he took hours to scrub and shine with his trusty ammonium chloride based floor cleaner.

**Crdk** Sammy works part time at a farm, and forgot to change out of his denim overalls when he went to the hotel to work. He and Joey had a friendly conversation about his attire, then Sammy went to work on the cameras. Sammy was fixing the security cameras during the time when the theft occurred. He used some eye drops because his eyes were irritated from staring at screens for too long.

**Gxlf gpeg:** Powders P7 and P8, Hair H4, and Fiber F4. Sammy uses Pen 1

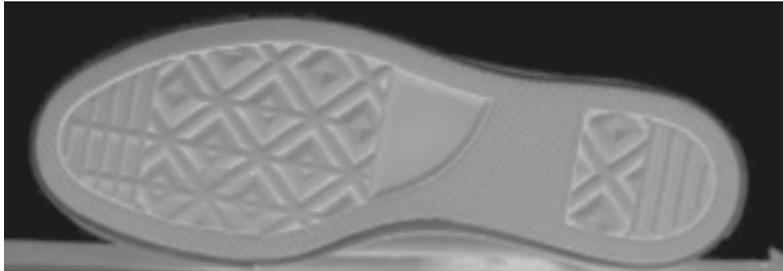
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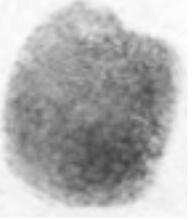
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Name: <b>Lqg{ 'Lqg'</b> ID# 10705		Ref. Case # _____ <b>FINGERPRINT CARD</b> For Police Department Use Only		
1. RIGHT THUMB 	2. RIGHT INDEX 	3. RIGHT MIDDLE 	4. RIGHT RING 	5. RIGHT LITTLE 
1. LEFT THUMB 	2. LEFT INDEX 	3. LEFT MIDDLE 	4. LEFT RING 	5. LEFT LITTLE 

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Name: <b>Y km{ 'Y km'</b> ID# 29888		Ref. Case # _____ <b>FINGERPRINT CARD</b> For Police Department Use Only		
1. RIGHT THUMB 	2. RIGHT INDEX 	3. RIGHT MIDDLE 	4. RIGHT RING 	5. RIGHT LITTLE 
1. LEFT THUMB 	2. LEFT INDEX 	3. LEFT MIDDLE 	4. LEFT RING 	5. LEFT LITTLE 

Name: <b>O qm 'O q</b> ID# 43253		Ref. Case # _____		
		<b>FINGERPRINT CARD</b>		
		For Police Department Use Only		
1. RIGHT THUMB 	2. RIGHT INDEX 	3. RIGHT MIDDLE 	4. RIGHT RING 	5. RIGHT LITTLE 
1. LEFT THUMB 	2. LEFT INDEX 	3. LEFT MIDDLE 	4. LEFT RING 	5. LEFT LITTLE 

Name: <b>Uco o { 'Uco ''</b> ID# 94165		Ref. Case # _____		
		<b>FINGERPRINT CARD</b>		
		For Police Department Use Only		
1. RIGHT THUMB 	2. RIGHT INDEX 	3. RIGHT MIDDLE 	4. RIGHT RING 	5. RIGHT LITTLE 
1. LEFT THUMB 	2. LEFT INDEX 	3. LEFT MIDDLE 	4. LEFT RING 	5. LEFT LITTLE 

**Scientific Names**

(When stating the identity of each substance, please write out scientific names unless otherwise stated. I.e. "Aluminum Nitrate")

1. Powder U1 burned with a bright yellow flame and had a pH of 8. It didn't react with HCl. What is the identity of this substance?
  - a. Is this substance molecular or ionic? Why?
2. Powder U2 had a pH of 7, a conductivity of 83 ms. What is the identity of this substance?
3. Powder P1 bubbled when burned and created a sticky substance. It does not have a free aldehyde group. What is the identity of this substance?
4. Powder P2 bubbled intensely with HCl, and had a pH of 8. What is the identity of this substance?
  - a. What does HCl test for?
5. Powder P3 formed a precipitate with NaOH, and had a pH of 6. What is the identity of this substance?
6. Powder P4 burned with a bright red flame. What is the identity of this substance?
  - a. Explain the mechanism behind the colors observed during the flame test?
7. Powder P5 did not react when heated with Benedict's solution and has a molar mass of 342.297 g/mol. What is the identity of this substance?
8. Powder P6 had a pH of 7, and burned with a bright yellow flame. What is the identity of this substance?
9. Powder P7 burned with a faint green flame, and had a pH of 6. What is the identity of this substance?
  - a. Name two uses of this substance
10. Powder P8 is partially nonconductive, and has a melting point at 171 degrees celsius. What is the identity of this substance?
  - a. Write the chemical formula of this substance

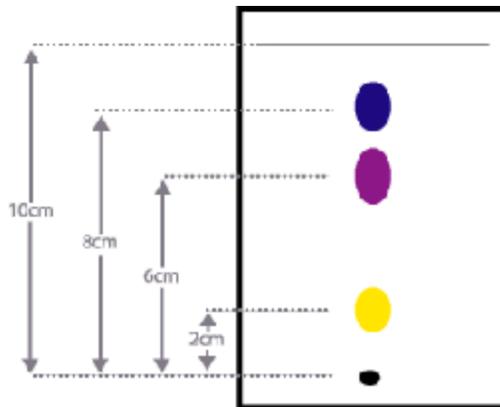
**Fingerprint Development**

Fingerprint Development	Fingerprint Development
	

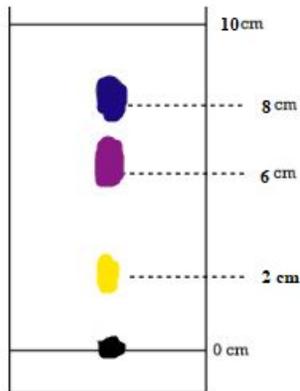
11. Complete the following statement: Fingerprints develop around \_\_\_\_ week, and are complete by \_\_\_\_ month
12. In which skin layer are fingerprints located?

13. The average adult has how many ridges on each finger?
14. What are the three main types of fingerprints?
  - a. What are their respective percent abundances?
15. What method of development would be best for wet nonporous surfaces?
16. Why should Silver nitrate be used only if other methods fail?
  - a. Explain the chemistry behind silver nitrate development
17. What type of fingerprint is U1?
18. What type of fingerprint is U2?
19. Which suspect's fingerprint matches with U1? On which hand and which finger?
20. Which suspect's fingerprint matches with U2? On which hand and which finger?

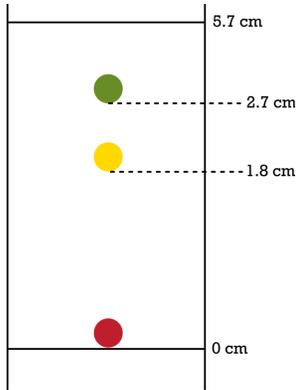
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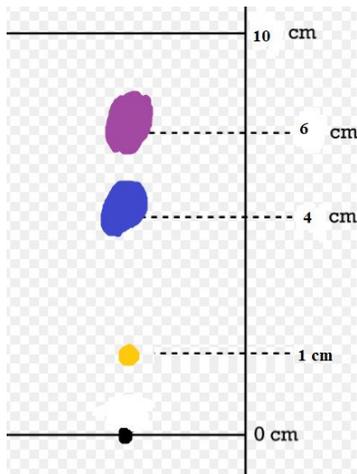
Crime scene:



Pen 1:



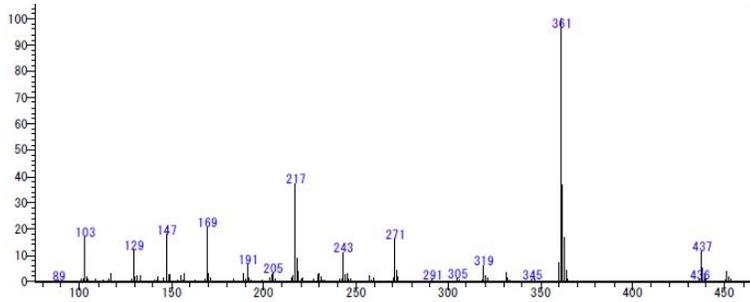
Pen 2:



Pen 3:

21. What is the Rf value of the ink from the note at the crime scene?
22. What is the Rf value of pen 1?
23. What is the Rf value of pen 2?
24. What is the Rf value of pen 3?
25. What does Rf stand for?
26. Which pen matches the Rf from the ink from the crime scene?
27. Who does this implicate?
28. What is the stationary phase in paper chromatography?
29. What is the difference between normal and reverse phase chromatography?
30. Who invented chromatography?
31. What does TLC stand for?
  - a. List two real world applications of TLC.

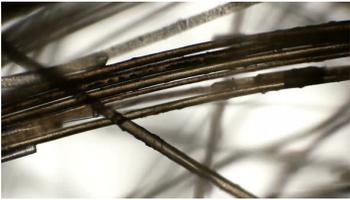
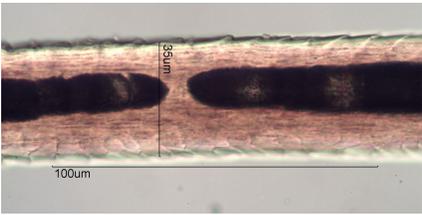
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32. Find the Molecular ion peak:
33. Find the base peak:
34. What does the x-axis represent?
35. What does the y-axis represent?
36. Which suspect(s) does this mass spec indicate?
37. What is the difference between a presumptive and a confirmatory test? Which does mass spec fall into?
38. Describe the degree of fragmentation that corresponds with hard ionization and soft ionization.

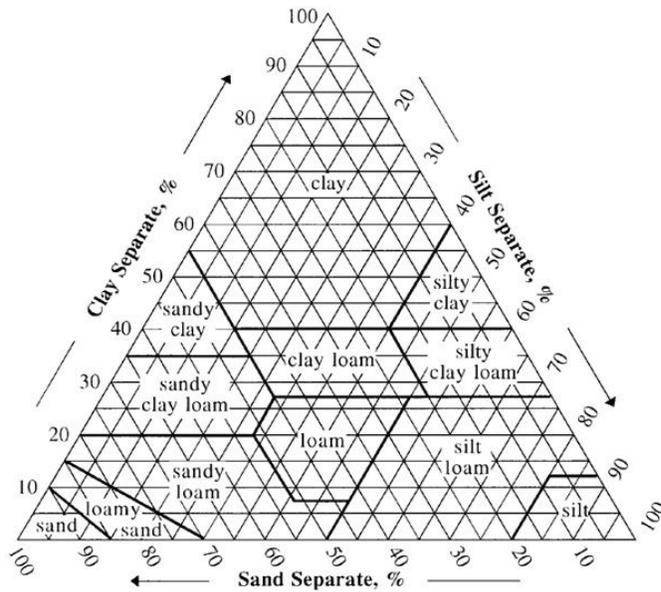
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Hair U1:	
Hair U2:	

Hair H1:	
Hair H2:	
Hair H3:	
Hair H4:	

39. What animal does Hair U1 come from?
40. What animal does Hair U2 come from?
41. What animal does Hair P1 come from?
42. What animal does Hair P2 come from?
43. What animal does Hair P3 come from?
44. What animal does Hair P4 come from?
45. List the three layers of hair from innermost to outermost
46. Where in hair can mitochondria DNA be found?
47. Where in the hair strand can nuclear DNA be found?
48. In what stage of hair growth is the most growth occurring?
49. How much hair from the scalp is needed for a proper control sample size?
50. What type of cuticle does human hair have?

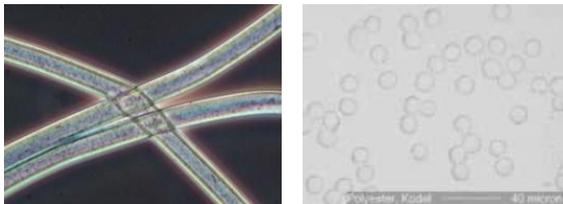
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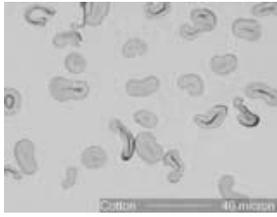
51. The soil from the crime scene was 10% clay, 20% silt, and 70% sand. What type of soil is this?
52. What type of soil is the best for growing crops?
53. Which type of soil has the lowest water holding capacity?
  - a. What is its diameter?
54. What are the soil horizons from uppermost to lowermost?
55. What chemical does white color in soil indicate?

## Hdgtu'

56. Fiber U1 drips when burned, has a sweet smell, and has a hard residue. What is the identity of this fiber?
  - a. List two uses of this fiber
57. Fiber U2 shrivels when burned, has a brown-black residue, and smells like burning hair. What is the identity of this fiber?
  - a. List two uses of this fiber
58. Fiber F1 self extinguishes, and is made of keratin. What is the identity of this fiber?



59. Fiber F2 is shown above. What is the identity of this fiber?
60. Fiber F3 leaves a charred whitish ash after burning, and burns with a gray smoke. What is the identity of this fiber?



61. What is the identity of Fiber F4 (above)?
62. Draw a monomer of Polyester
63. Draw a monomer of nylon
64. Draw a monomer of spandex
65. Why does wool dissolve in bleach (what type of reaction occurs)?

**Conclusion'**

Which suspect(s) most likely committed this crime?

Why? Provide reasoning and evidence.