

# A Sofishticated Theft- Questions



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

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

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

## Rules:

You have 50 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! :)

Points from Questions: 94

Points from Analysis: 57

Total points: 151

(No tiebreakers)

**Qualitative Analysis: 17 points**

(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 was slightly basic. It didn't react with HCl. What is the identity of this substance?

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a. Is this substance molecular or ionic?

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2. Powder U2 had a pH of about 7, a conductivity of approximately 83 ms. What is the identity of this substance?

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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?

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4. Powder P2 bubbled intensely with HCl, and had a pH of approximately 8. What is the identity of this substance?

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a. In the context of forensics powders, what does HCl test for?

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5. Powder P3 formed a precipitate with NaOH, did not burn with a distinctive flame color, and had a pH of about 6. What is the identity of this substance?

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6. Powder P4 burned with a bright red flame. What is the identity of this substance?

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a. Explain the mechanism behind the colors observed during the flame test.

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7. Powder P5 did not react when heated with Benedict's solution and has a molar mass of approximately 342.297 g/mol. What is the identity of this substance?

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8. Powder P6 had a neutral pH, did not react with HCl, and burned with a bright yellow flame. What is the identity of this substance?

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9. Powder P7 burned with a faint green flame, and had a pH of approximately 6. What is the identity of this substance?

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a. Name two uses of this substance

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10. Powder P8 is partially nonconductive, and has a melting point at 171 degrees celsius. What is the identity of this substance?

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a. Write the chemical formula of this substance

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**Hair: 13 points**

11. What animal does Hair U1 come from?

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12. What animal does Hair U2 come from?

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13. What animal does Hair P1 come from?

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14. What animal does Hair P2 come from?

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15. What animal does Hair P3 come from?

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16. What animal does Hair P4 come from?

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17. List the three layers of hair from innermost to outermost

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18. Where in hair can mitochondrial DNA be found?

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19. Where in the hair strand can nuclear DNA be found?

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20. In what stage of hair growth is the most growth occurring?

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21. How much hair from the scalp is needed for a proper sample size for a drug test?

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22. What type of cuticle does human hair have?

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**Fibers: 14 points**

23. Fiber U1 drips when burned, has a sweet smell, and has a hard residue. What is the identity of this fiber?

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a. List two uses of this fiber

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24. Fiber U2 shrivels when burned, is the most commonly used animal fiber, and has a brown-black residue. What is the identity of this fiber?

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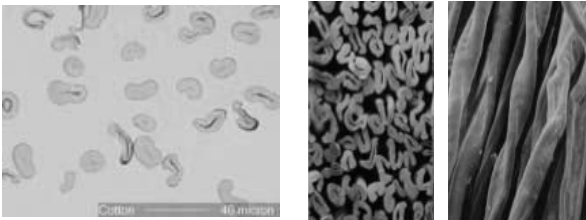
a. List two uses of this fiber

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25. Fiber F1 self extinguishes, and is made of keratin. What is the identity of this fiber?

26. Fiber F2 can have any length, melts, and produces hard colored ash. What is the identity of this fiber?

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



28. What is the identity of Fiber F4 (above)?

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29. Draw a monomer of Polyester

30. Draw a monomer of nylon



31. Draw a monomer of spandex



32. Why does wool dissolve in bleach, and what type of reaction occurs?

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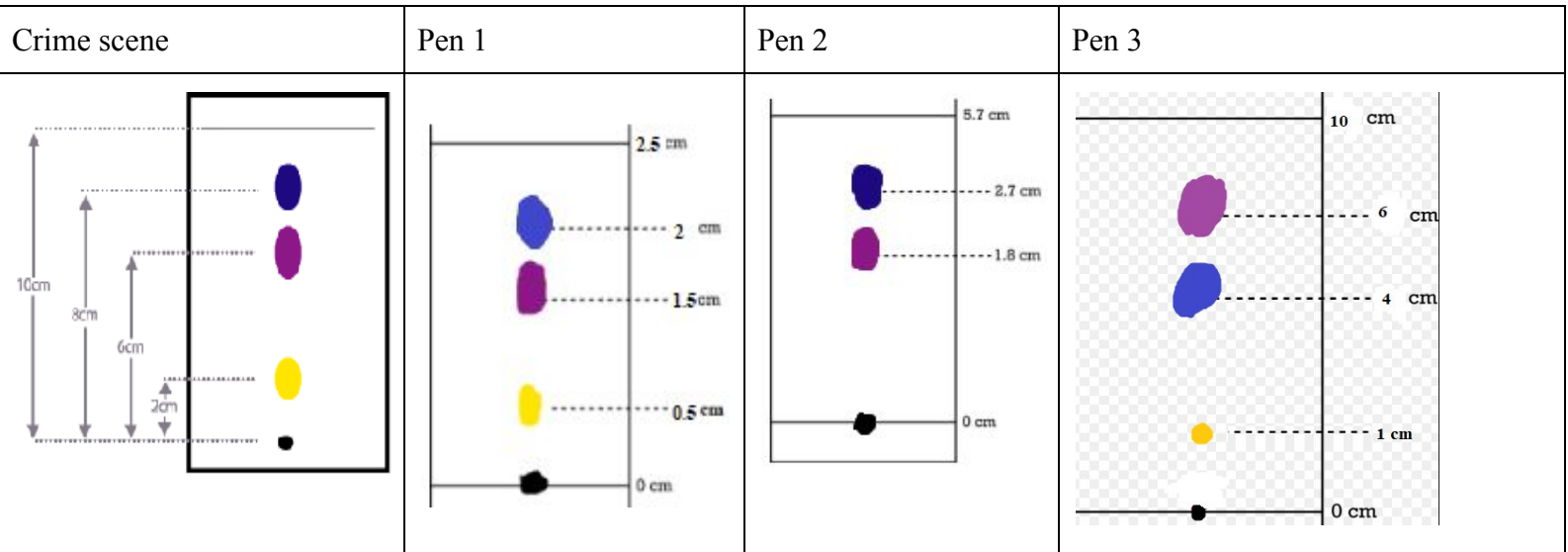
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**Chromatography: 15 points**

(round the Rf values to the nearest tenth if rounding is necessary)



33. What are the Rf values of the ink from the note at the crime scene?

34. What are the Rf values for pen 1?

35. What are the Rf values for pen 2?

36. What are the Rf values for pen 3?

37. What does Rf stand for?

38. Which pen matches the Rf from the ink from the crime scene?

39. Who does this implicate?

40. What is the stationary phase in paper chromatography?



41. What is the difference between normal and reverse phase chromatography?

42. Who invented chromatography?

43. What does TLC stand for?

a. List two real world applications of TLC.

**Fingerprints: 18 points**

<b>Fingerprint U1:</b>	<b>Fingerprint U2:</b>
	

44. Complete the following statement: Fingerprint ridge patterns finish developing in the human fetus by about \_\_\_\_ months.

45. In which skin layer are fingerprints located?

46. The average adult has how many ridges on each finger?

47. What are the three main types of fingerprints?

a. What are their respective percent abundances?

48. What method of development would be best for wet nonporous surfaces?

49. Why should silver nitrate be used only if other methods fail?

a. Explain the chemistry behind silver nitrate development

50. What type of fingerprint is U1?

51. What type of fingerprint is U2?

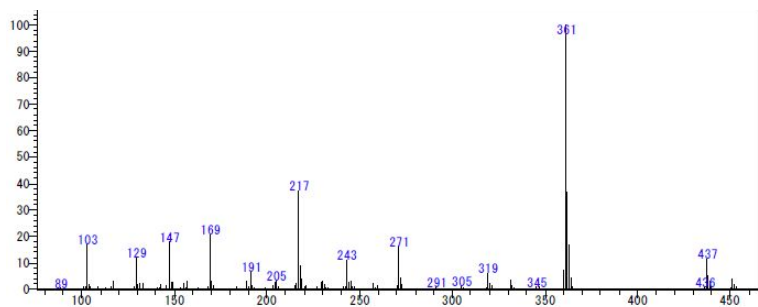
52. Which suspect's fingerprint matches with U1?

a. If it matches with one of the suspects, which hand and which finger is the fingerprint on?

53. Which suspect's fingerprint matches with U2?

a. If it matches with one of the suspects, which hand and which finger is the fingerprint on?

## Mass Spectrometry: 11 points



54. What is the value of the molecular ion peak?

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55. What is the value of the base peak?

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56. What does the x-axis represent?

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57. What does the y-axis represent?

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58. Which suspect(s) does this mass spec indicate?

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59. What is the difference between a presumptive and a confirmatory test? Which does mass spec fall into?

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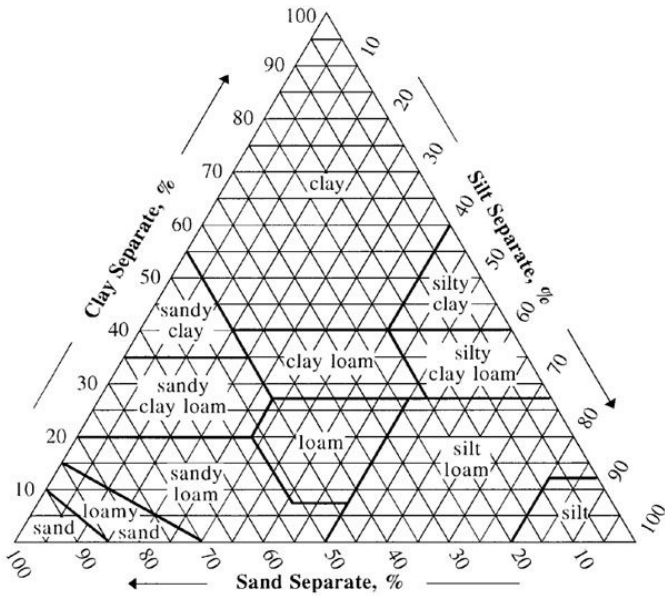
60. Describe the degree of fragmentation that corresponds with hard ionization and soft ionization.

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**Soil: 6 points**



61. The soil from the crime scene was approximately 10% clay, 20% silt, and 70% sand. What type of soil is this?

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62. What type of soil is the best for growing crops?

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63. Which type of soil has the lowest water holding capacity?

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a. What is its diameter?

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64. What are the soil horizons from uppermost to lowermost (please give the letter abbreviations)?

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65. What chemical does white color in soil indicate?

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**Analysis:**

- a) Which suspect(s) most likely committed this crime?
  
- b) Why? Provide reasoning and evidence.