Information provided by the Yale Police

The Crime
Three days ago, fifty-two high students from around the world arrived at Yale, for the Yale Young Global Scholars program. Some of them, however, had other aims…
Video footages show a child, wearing black overalls, vandalizing the statue on Old Campus. The crime took place from 10:47 PM to 10:49 PM. Due to the late hour, no witnesses were to be seen, at least in the video. The statue was smeared with permanent black ink, and obscene remarks were carved into it. Despite the video’s bad quality, Yale Police have narrowed down the search to four students, who were late for the 11 PM lights out attendance at the Omni New Haven Hotel. The Omni Hotel is a 5-minute walk from old campus. The Police now need your help to investigate and discover the mischief maker.

The Suspects
All four suspects were wearing different colored clothes the night of the crime, however their friends do not recall the specific colors of their outfits. Black overalls were found in Jake and Chris’s luggage; however, the low video quality might be inconclusive evidence.

• **Jake** is medium sized, and is a known mischief-maker at school. He is a smoker, and was caught with a packet of cigarettes on Yale’s campus, on the day of the crime. He was absent from the workshop throughout the day, only attending it for the first twenty minutes or so. He returned to his room at 11:02 PM, and said he was hanging out with some Yale undergraduates. The police have failed to confirm his story.

• **Chris** is a tall fair guy, and wears glasses. He owns a German Shephard, and had brought the dog on campus for the event. He is a chocoholic, and is known to carry his stash with him, wherever he goes. His whereabouts were unknown from around 10:00 PM to 11:10 PM.

• **Dave** is a tall guy, who is a famous athlete at Westminster school. He is extremely organized, and carries around a planner and pen with himself all the time. He left his room for a bathroom break at around 10:45 PM and returned twenty minutes later. His teachers consider him least likely to have committed the vandalism, since he is ‘not that kind of a kid’ to quote Westminster’s staff advisor.

• **Andreas** is short, and is normally well-behaved, according to his teachers. However, he has a short temper and often resorts to destruction when teased by his peers. He has a serious demeanor, and normally remains to the point. He left the hotel for half an hour, at around 10:30 PM, saying he was going out to get some fresh air.
The Yale Police will provide you with four updates as their investigation continues.

Section I – Short Questions  [50 points]

1) A white powder was found at the scene of the crime. It burns to give an orange flame. What might the powder be? [2 points]
   a. calcium chloride   c. lithium chloride
   b. calcium carbonate   d. magnesium sulfate

2) Traces of a white powder were also found in Jake’s pocket. When some dilute ethanoic acid was poured onto it, a gas was produced which turned lime water milky.
   a) What is the gas? [2 points]
   b) What might the white powder be? [2 points]
      a. lithium chloride   c. sodium chloride
      b. sodium carbonate   d. calcium nitrate
3) What would you use to identify cornstarch? [2 points]
   a. cobalt  
   b. ethanol  
   c. Iodine  
   d. ammonia

   **Update 1:** A plastic wrap containing traces of beef jerky was found at a garbage can beside the statue.

4) A faint odor of burnt hair can be noticed from the plastic.
   What is the plastic? [2 points]
   a. PVC  
   b. LDPE  
   c. PTFE  
   d. HDPE

   **Update 2:** The Yale Police has now decided to use DNA analysis. You will be provided with the results soon.

5) What type of bonds do guanine–cytosine and adenine-thymine form? [2 points]

6) The DNA fingerprints taken from blood samples of Andreas, Chris, Dave and Jake respectively, are shown on the left. The DNA fingerprints taken from the statue, is on the right.
   Does the crime scene sample match the DNA fingerprints of any of the subjects? If yes, to whom does the evidence point? Explain. [2 points]

   ![DNA fingerprints](image)

   A  C  D  J  Crime Scene

   **Update 3:** Hair was collected from the area surrounding the statue.

7) Was this DNA analysis useful? Why or why not? [2 point]

8) Draw a fully labelled diagram of hair structure. [4 points]

9) Compare the *relative* density, nature and growth pattern of humans’ and dogs’ hair. [4 points]
10) Analyze a microscope image of the hair found near the statue. To what species does this hair belong to? Explain your answer. [4 points]

11) This evidence points to ___________________________. [2 points]

Update 4: Red pens found with each of the four suspects were seized.

12) The Police thinks performing paper chromatography is unnecessary and a waste of time and money. You are supposed to explain to the Yale Police Chief:
   a) how paper chromatography is performed, [4 points]
   b) how it will help you reach the wrongdoer. [1 point]

13) The results are as follows:

14) Label the following fingerprint patterns. [6 points]
15) A plain whorl fingerprint was found on the statue. Fingerprints of the four suspects are provided below. To whom does this evidence point to? Explain how you identified the fingerprint. [3 points]

[Images of fingerprints labeled Andreas, Chris, Dave, Jake]

16) Use information from all questions, and write down who you think committed the crime. You do not need to explain your answer yet. [3 points]

Section II – Laboratory Procedures and Safety Precautions [10 points]

Iodine fuming is a method of fingerprint analysis.

1) Describe the procedure of iodine-fuming. Name any materials which must be used, the limitations of this method, and the optimal conditions for the analysis to work. [6 points]
2) Write down any four laboratory precautions which must be taken while performing the above experiment. [4 points]

Section III – Analysis and Conclusion [30 points]

The investigation is now over. You must write down your report of the crime, discussing all aspects of the investigation, the evidence collected, the evidence discarded and the difficulties faced by you. Answer the following questions in your analysis.

- Who committed the crime?
- Why you ruled out the other suspects?
- Was there any contradictory evidence? How did you choose between them?
- Any possible motives?
- How does the information provided by the Police match your theory?