

Science Olympiad 2016 Forensics Tryout Test

Note for Examinees: Examinees should have no more than 5 pages of notes. This test should be completed in a 50 minute period. There will be identification questions leading you to identify the suspect, but also general knowledge questions to test understanding of Forensics knowledge.

Note for Proctors: A large part of what makes Forensics challenging is the lab aspect - this test is designed to be done without the use of lab (as it is a tryout test), but can easily be modified to be done with a lab portion.

The Scenario:

Someone has shot and killed beloved Patriots Quarterback Tom Brady. Powders C and G were found at the scene, along with a piece of fiber A. Also, Hair B and Plastic C were found at the crime scene. A fingerprint was found on the gun left at the crime scene as well.

The Suspects:

Bill Belichick: The beloved head coach of the New England Patriots. He has long had a good relationship with Tom, but there were reports that they were fighting earlier that day because of Tom's refusal to accept some of Belichick's decisions. Belichick was reported to have made many threats and stormed off.

Belichick was reported to have been working with heating packs (Sodium Acetate) and some Marble Limestone (Calcium Carbonate). Also, he prefers cotton clothing and has a cat. He is also in charge of buying milk chugs for the team (HDPE). He has fingerprint A (see fingerprint section).

Jimmy Garoppolo: Backup quarterback to Tom Brady. They are friends, but Jimmy has always believed that he is better and that he deserves the starting role. This causes some friction between them.

Jimmy enjoys baking (Sodium Bicarbonate) and uses lots of fertilizer (Calcium Nitrate). He prefers linen clothing and has a dog. He also buys many of the disposal cups and plates for the team (PS), and has fingerprint B.

Gisele Bundchen: Tom Brady's wife. She is usually very cooperative, but lately her and Tom had been fighting because he had been spending far too much time playing football and not spending enough time with her.

Gisele enjoys making dry cell batteries (Ammonium Chloride) and uses a lot of sugar in her cooking (Glucose). She prefers silk clothing and often rides horses in her free time. She also drinks many soft drinks from bottles (PETE). She has fingerprint C.

Julian Edelman: Star wide receiver on the Patriots. Often overlooked due to Brady's greatness, and has lately been thrown to a lot less by Brady. Was seen crying because Brady yelled at him after a game during which he missed a catch. Edelman eats very salty foods (Sodium Chloride), and often takes pills to treat his bipolar disorder (Lithium Chloride). He enjoys wearing wool clothing and has a pet bat. He also buys many plastic containers for the team (LDPE), and has fingerprint D.

Part A: Qualitative Analysis (worth 20%)

Powder A is soluble in water, and melts in a flame (producing a yellow color). It has a Ph of around 6 and doesn't react in Benedict's solution. It also clearly dissolves in Sodium Hydroxide.

1. What is powder A?

2. What is the molar mass of powder A?

Powder B is soluble in water, and highly conductive. It flame tests yellow, doesn't react in Benedict's solution or hydrochloric acid, and has a Ph of around 6. It dissolves slowly in Sodium Hydroxide.

3. What is powder B?

4. What is the molar mass of powder B?

Powder C is soluble in water, and highly conductive. It flame tests yellow, and reacts to form bubbles in Benedict's and fizzes in hydrochloric acid.

5. What is powder C?

6. What is the molar mass of powder C?

Powder D is soluble in water and highly conductive. Its flame test is yellow, it doesn't react with Benedict's solution or hydrochloric acid, and has a pH of around 8. It does not dissolve in sodium hydroxide.

7. What is powder D?

8. What is the molar mass of powder D?

Powder E is not soluble in water, and not very conductive. It glows bright in a flame, but doesn't burn. It doesn't react in Benedict's solution, but fizzes in hydrochloric acid.

9. What is powder E?

10. What is the molar mass of powder E?

Powder F is soluble in water, and is highly conductive. It polymerizes in a flame, and turns dark blue in Benedict's.

11. What is powder F?

12. What is the molar mass of powder F?

Powder G is soluble in water, and is highly conductive. It produces red-orange sparks in a flame test, and doesn't react in Benedict's nor hydrochloric acid. It does not dissolve in sodium hydroxide.

13. What is powder G?

14. What is the molar mass of powder G?

Powder H is soluble in water, and highly conductive. Its flame test is red, it doesn't react with Benedict's solution or hydrochloric acid, and has a pH of around 6. It dissolves slowly in sodium hydroxide.

15. What is powder H?

16. What is the molar mass of powder H?

Write the color that the following ions will produce in a flame test:

17. Li^+ , Sr^{2+} , Ca^{2+}

18. Na^+

19. K^+

20. Cu^{2+}

Part B: Polymers (worth 20%)

Fibers

Fiber A is not self extinguishing, smells like burning paper, and has no afterglow and burns slowly.

1. What is Fiber A?

Fiber B smolders and shrinks away from flame, doesn't melt, and extinguishes itself. It produces a round, shiny black bead.

2. What is Fiber B?

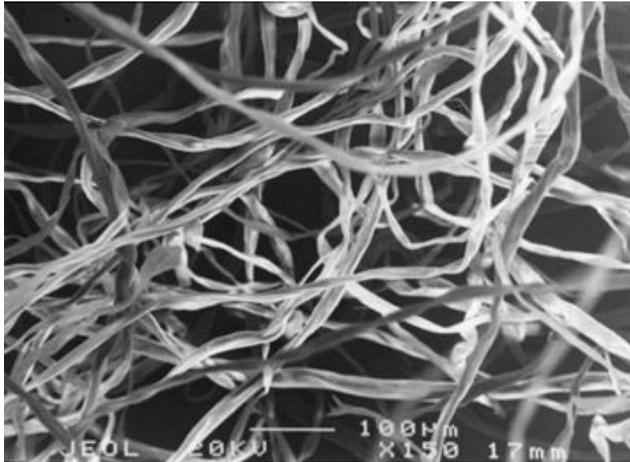
Fiber C smolders and shrinks away from flame, doesn't melt, and extinguishes itself. It produces a crisp, dark, irregular bead.

3. What is Fiber C?

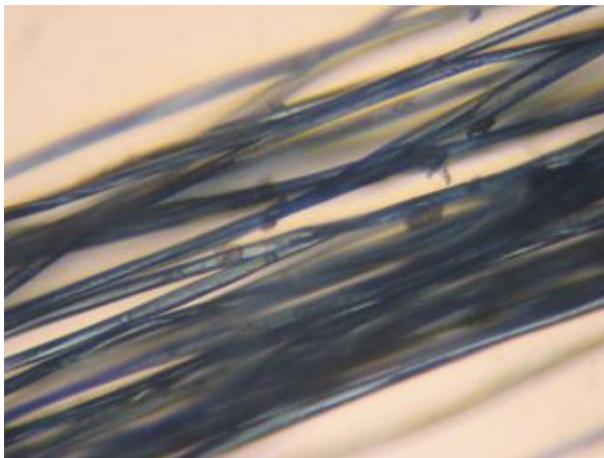
Fiber D is not self extinguishing, smells like burning paper, and has an afterglow and burns quickly.

4. What is Fiber D?

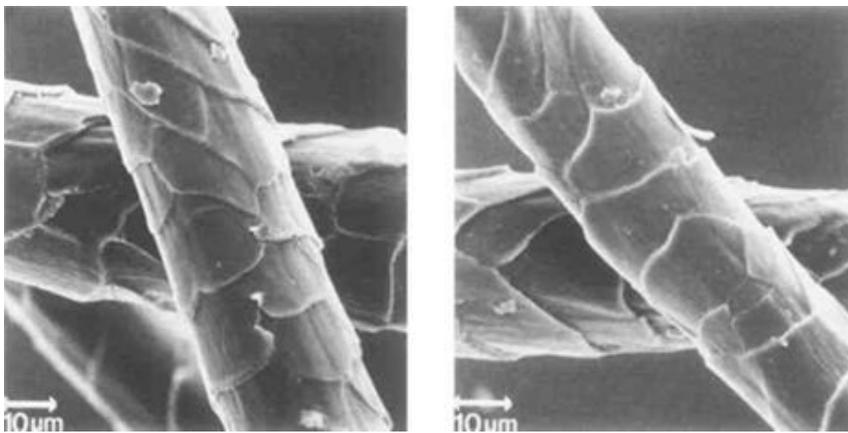
Write what each fiber is based on its microscopic image (write your answer under the corresponding image):



5.



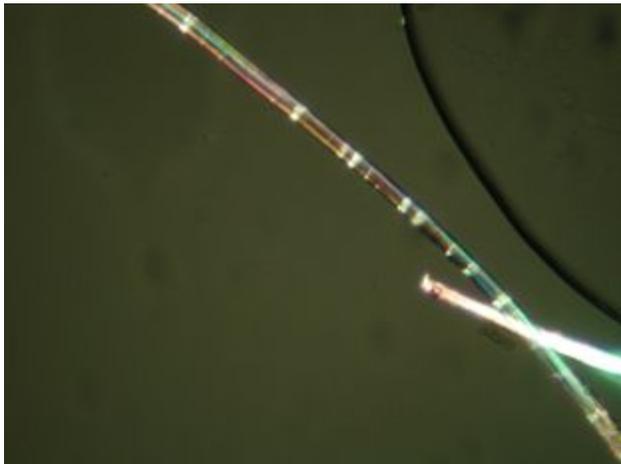
6.



7.



8.



9.

Plastics

Use density clues to determine identity of plastics:

Plastic A floats in water, but sinks in 46% Isopropyl Alcohol.

10. What is plastic A?

Plastic B sinks in water, 10% NaCl, and Saturated NaCl. It produces a green flame in the Copper wire test.

11. What is plastic B?

Plastic C sinks in water, but floats in 10% NaCl.

12. What is plastic C?

Plastic D floats in water, 46% Isopropyl Alcohol, but sinks in vegetable oil.

13. What is plastic D?

14. Draw one monomer of PVC.

Hairs

Hair A



15. From what animal is hair A?

Hair B



16. From what animal is hair B?

Hair C



17. From what animal is hair C?

Hair D



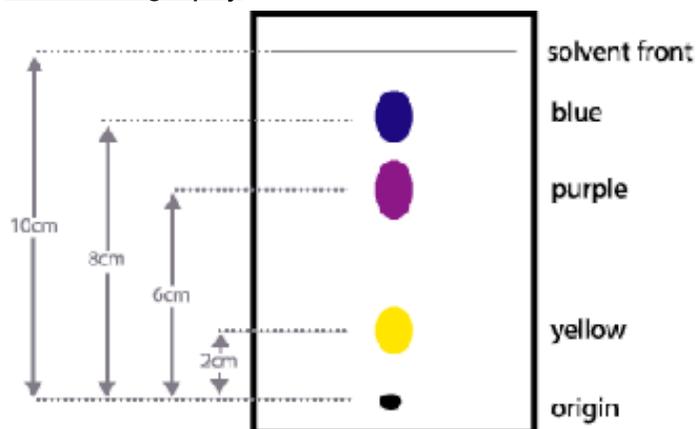
18. From what animal is hair D?

19. What protein is hair primarily composed of?

20. What are the 3 major growth stages of hair?

Part C: Chromatography/Spectroscopy (worth 15%)

Chromatography



1. What is the R_f for the blue compound?
2. What is the R_f for the purple compound?
3. What is the R_f for the yellow compound?
4. What does R_f stand for?
5. In paper chromatography, what is the “stationary phase”?
6. In paper chromatography, what is the “mobile phase”?
7. Which compound is most attracted to the solvent?
8. Which compound is least attracted to the solvent?

Spectroscopy

9. If the $M+1$ peak has a relative intensity of 4.4%, how many Carbon atoms are present in the molecule?
10. If the $M+2$ peak has approximately the same intensity of the M peak, this indicates presence of which atom?
11. The nitrogen rule states that if the m/z for M is odd then the molecular formula must have?

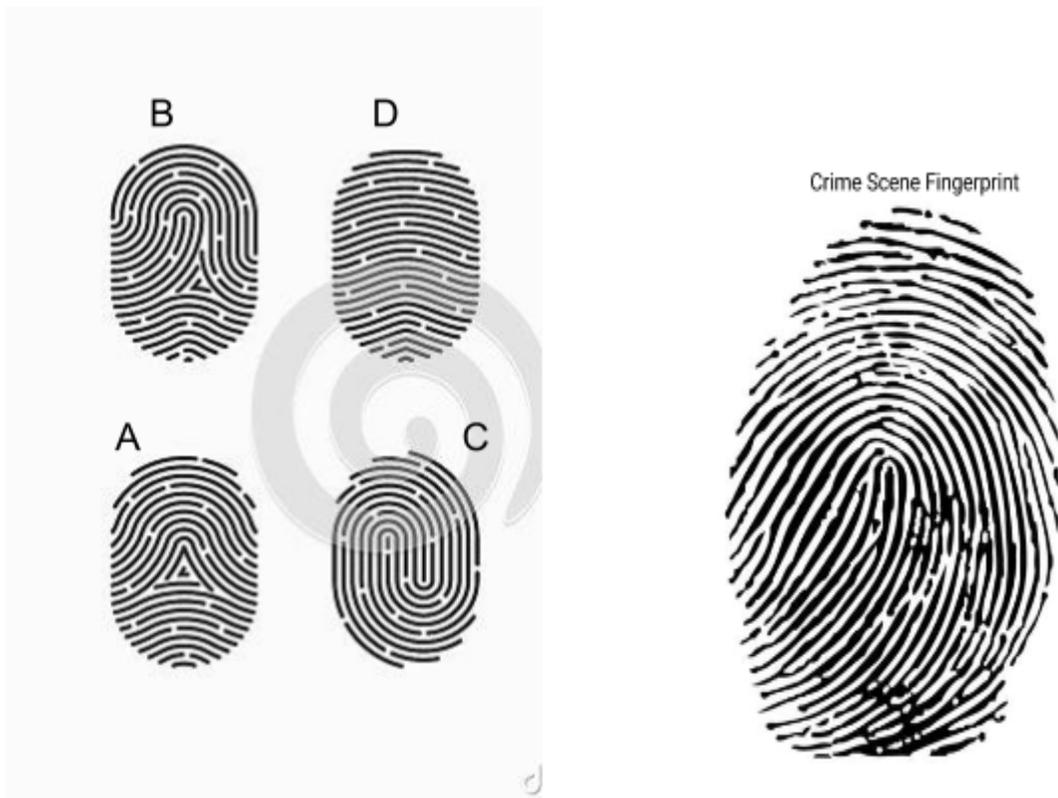
	m/z	Relative Intensity
M	59	100%
M+1	60	3.85%
M+2	61	0.0127%

12. Given the following relative intensity data, determine the molecular formula of the compound.

13. How does mass spectrometry work?

Part D: Physical Evidence (worth 15%)

Suspect Fingerprints:



1. Which suspect has a fingerprint most closely matching the crime scene fingerprint?

2. What fingerprint classification is fingerprint A?

3. What fingerprint classification is fingerprint B?
 4. What fingerprint classification is fingerprint C?
 5. What fingerprint classification is fingerprint D?
 6. Only 5% of the population has what type of fingerprint?
- For questions 7-13, label the following diagram of fingerprint minutiae



14. Which fingerprint identification method is also known as the “super glue” method?
15. Which fingerprint identification method turns the prints purple?

Part E: Analysis of the Crime (worth 30%)

Write who you think committed the crime and evidence to support why.