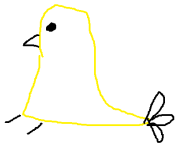
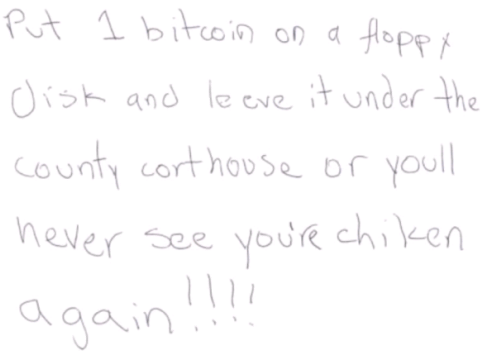
Forensics C - UT Regional 2021 Forensics Exam - UT C - 03-27-2021

Per Texas Science Olympiad rules, you must have printed notes for this event. If you are communicating with your partner through a voice or video call, please start it before you begin the test itself.

Significant time spent outside of the browser window is grounds for a penalty or disqualification per TSO policies.



Scenario: Farmer Joe has called you, a foremost forensics investigator, to his farmhouse because someone had stolen his prized chicken from his coop. Apparently, his chicken was insured for a million dollars because it apparently lays perfect soft-boiled eggs. A ransom note was left behind:



You don't really believe his chicken had the ability to lay perfectly cooked dairy, but you decided to head out to his farmhouse anyways. You encounter Farmer Joe at his house, alongside his daughter Jesse. Farmer Joe claims that the people that could have stolen his chicken were the plumber Mike who came this morning, Jesse's boyfriend Sam, or David, the salesman who found the note outside his door.

Suspects:

Suspect 1: Farmer Joe

Farmer Joe is an animal farmer. He really loves his prized chicken, because he sells the soft-boiled eggs as the main contributor to his income (they're really that finger lickin good). He's also not afraid to show it off to all his guests but never lets them in the enclosure. Farmer Joe is wearing denim overalls, as any other reasonable farmer does. He is also sporting a nice pair of sketchers. He is currently facing an insect problem in his house so he carries solid insecticide around with him. At the time of the crime, Farmer Joe mentions that he was busy trying to combat the bat infestation at his shed. Farmer Joe is actually very scared of cows and he makes sure to keep them far away from himself and his prized chicken's coop. His blood type is AB-, and his left thumb has a double loop whorl.

Suspect 2: Plumber Mike

Plumber Mike is one of Joe's neighbors and is over all the time helping out Farmer Joe with various plumbing things, like recently laying new pipes down. In return, Farmer Joe always sends him back home with a few fresh soft-boiled eggs laid by the prized chicken. Plumber Mike really loves his soft-boiled eggs. He also makes sure to pet his favorite cow on every visit. Recently, he has been complaining about his nylon tracksuit chafing so he has been using a cornstarch-based baby powder to help fix it. For fun, Plumber Mike plays with his pet squirrel and takes him on walks. At the time of the crime, Plumber Mike claims that he was fixing the pipes in the farmhouse's bathroom. Mike wears orthopedic shoes to help fix his posture since he has been slouching his entire life. His blood type is A- and his left thumb contains a radial loop fingerprint.

Suspect 3: Cowboy Sam

Cowboy Sam is Jesse's boyfriend, but Farmer Joe doesn't really like him because he's allergic to eggs. However, Jesse still loves him very much because he really appreciates cows, which is Jesse's second favorite animal after the horse. Farmer Joe lets Cowboy Sam work on his farm so he spends most of his time with the cows. Another thing he does around the farm is making fertilizer by mixing industrial fertilizer with cow manure. He is wearing a cotton shirt, denim jeans, and boots. He is also currently carrying a plastic water bottle with him. At the time of the crime, Cowboy Sam states that he was wrangling the cows. His blood type is A+ and his left thumb contains a tented arch.

Suspect 4: Horse Girl Jesse

Jesse is Farmer Joe's daughter who lives with him. As you might suspect, she likes horseback riding and is the one that cares for the horses on the farm. In fact, she always carries sugar cubes for the horses. Although her father disapproves of her boyfriend, she believes that she would be able to convince him to get over his egg allergies through the power of love. At the time of the crime, Jesse mentions that she was out on the field riding on her favorite horse, Omelette. She is currently wearing a wool sweater, tights, and is also sporting a pair of light-up Heelys. Her blood type is B+ and her left thumb contains a central pocket whorl.

Suspect 5: Salesman David

David is a salesman that specialises in selling fertilizers to farmers. Because of his prolonged exposure to the chemicals in the fertilizer, all his hair has fallen out. Salesman David is currently wearing a company-issued polyester suit, and is currently panicking because he is not meeting his quota today because of the investigation. At the time of the crime scene, he claims that he was walking up towards Farmer Joe's house, which was a long distance. By the time he managed to reach the house, he found the ransom note taped on Farmer Joe's front door. Salesman David has a blood type of O+ and his left thumb contains a plain arch.

Evidence:

You and the other investigators were able to find a number of pieces of evidence on the scene of the crime. You were able to find samples of powders around the chicken enclosure in additions to some polymers. You were also able to identify some hairs that were stuck on the coop within the enclosure. A partial bootprint was also found directly in front of the latch to the chicken coop, however, you couldn't grab enough of it to identify anyone. Looking ahead, you also performed chromatography on all the available pens. Pen A is Plumber Mike's company branded pen. Pen B is Farmer Joe's pen, although anyone who works/lives with him has access to it. Finally, Pen C is a Holiday Inn pen Door to Door Salesman David took with him and uses for writing. The Rf values for the pens are listed below:

Pen A: Red: 0.92 Blue: 0.57 Purple: 0.20

Pen B: Red: 0.88, Blue: 0.56, Purple: 0.24

Pen C: Red: 0.81 Blue: 0.55 Purple: 0.45

After analyzing the crime scene, detectives were able to find samples of a few distinct powders. However, the bungling fools at the crime lab mixed up some of the evidence with another case's. It's up to you to not only identify the powders, but figure out which are relevant to the case. The crime lab has provided data from their tests for powders A, B, C, D, and E.

1. (1.00 pts)
Our crime lab tested powder A in an acid solution, but it was found to not be soluble. Application of an iodine reagent resulted in the powder taking on a black coloration. What is the identity of powder A?

Expected Answer: Cornstarch

2. (1.00 pts) What is/are the most likely source(s) of powder A if any exists?

Expected Answer: Plumber Mike's baby powder

3. (1.00 pts) Why does this black coloration occur?

Expected Answer: The iodine molecules insert themselves into the amylose helix of the starch molecules.

4. (1.00 pts)
The crime lab also tested powder B by dissolving it in an acid solution and a base solution. It was soluble, unlike powder A, however, no reaction was observed in either the acid or the base solution. A flame test was done on powder A which revealed a bright red flame. What is the identity of powder B?

Expected Answer: Lithium Chloride

5. (1.00 pts) What is/are the most likely source(s) of powder B, if any?

Expected Answer: Not related to case, or along the lines of automobile parts and metal production

6. (1.00 pts)
The tests on powder C revealed it was soluble, but did not produce a visible reaction in the acid or base. The flame test revealed a weak yellow-orange flame. To further investigate the identity of the powder, a Benedict's test was done. One of the interns accidentally added acid to the test mixture but Benedict's test was still positive! What is the identity of powder C?

Expected Answer: Sucrose

7. (1.00 pts) What is/are the most likely source(s) of powder C if any?

Expected Answer: Jesse's sugar cubes or along the lines of sugar

8. (1.00 pts) Why did the flame test reveal a weak yellow-orange flame when powder C was tested?

Expected Answer: Possible contamination from sodium, which produces a very bright flame.

9. (1.00 pts) What color does a Benedict's solution become during a positive test?

Expected Answer: Reddish Orange color (or anything similar)

10. (1.00 pts) Powder D was also soluble and produced a momentary green flame. What is the identity of powder D?

Expected Answer: Boric Acid

11. (1.00 pts) What is/are the most likely source(s) of powder D if any?

Expected Answer: Farmer Joe's Pesticide or along the lines of insecticide, flame retardant, nutritional supplement, fiberglass, anti-fungal.

12. (1.00 pts) Powder E has no reaction to acid or base and produces a very strong yellow-orange flame when burned. What is the identity of powder E?

Expected Answer: Sodium Chloride

13. (1.00 pts) What is/are the most likely source(s) of powder E if any?

Expected Answer: Not related to this case or along the lines of salt.

You find some polymers near the chicken coop and decide to perform some tests on them, and you realize that they are **PVC** and **PP**.

14. (1.00 pts) Who among the suspects is most likely to be the one using the PVC?

Expected Answer: Plumber Mike

15. (1.00 pts) Who among the suspects is most likely to be the one using the PP?

Expected Answer: Cowboy Sam

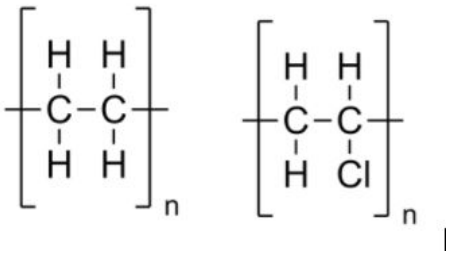
16. (1.00 pts) If a plastic chars, it is a thermoplastic.

○ True ◉ False

17. (1.00 pts)
A polymer has a number-average molecular weight of 3000 g/mol. Its monomer has a molar mass of 100 g/mol. What is the number-average degree of polymerization for this polymer?

Expected Answer: 30

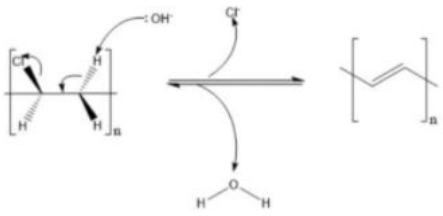
18. (1.00 pts) From your notes, you probably know that polyvinyl chloride (PVC) is more dense than polypropylene (PP).



Based on these structures, why would PVC be denser than PP? Note: assume the volumes of each monomer are roughly equal.

Expected Answer: Cl is heavier than H, so the mass of the monomer is higher. The volumes are roughly the same, so PVC will have a higher density

19. (1.00 pts)
PVC polymers can degrade over time by virtue of the chlorine group undergoing a process called dehalogenation that leads to the formation of alkenes that destabilize polymers under basic conditions. This process is shown below with a curved arrow diagram with a hydroxide ion representing a generic base.



Why would dehalogenation lead to instability in the structure of the polymer?

Expected Answer: Adjacent monomers are now oriented away from each other since the stereochemistry around the double bond is trans.

20. (1.00 pts) Polyester is the trade name for which of the Forensics plastics?

Expected Answer: PETE or Polyethylene terephthalate

21. (1.00 pts) In a couple of sentences, describe the general polymerization reaction to make this type of plastic.

Expected Answer: Condensation reactions occur when components are joined via the removal of a small molecule byproduct.

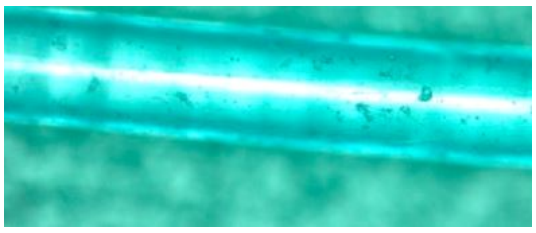
You also found two fibers on the crime scene.

22. (1.00 pts) Which of the following fiber properties are typically improved by mercerization? Select all that apply.

(Mark **ALL** correct answers)

- [x] A) Dye uptake
- [x] B) Dye affinity
- [x] C) Tear strength
- [x] D) Luster
- [ ] E) Malleability

23. (1.00 pts) A fiber at the crime scene is put under a microscope:



When subjected to a burn test, there is no ignition, but the fiber melts into a hard sphere. Furthermore, it has an acrid odor. What fiber is this?

Expected Answer: Nylon

24. (1.00 pts) Is the fiber natural or synthetic?

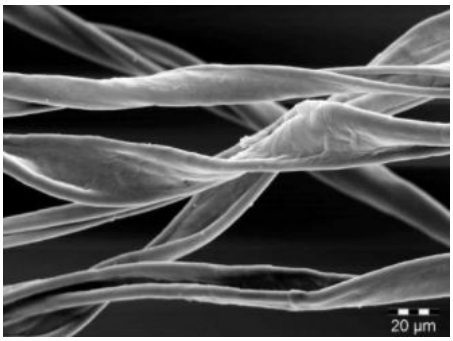
- ○ A) Natural

◉ B) Synthetic

25. (1.00 pts) What is/are the most likely source(s) of this fiber, if any?

Expected Answer: Jesse's tights and Plumber Mike's tracksuit

26. (1.00 pts)
A second fiber was found at the crime scene.



When subjected to a burn test, it burns consistently. It had a smell, but the investigators were not able to determine what the smell was. Finally, it left a whitish ash. What fiber is it?

Expected Answer: Cotton

27. (1.00 pts) It this fiber natural or synthetic?

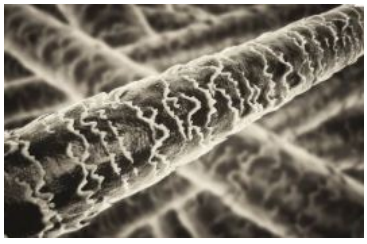
◉ A) Natural
○ B) Synthetic

28. (1.00 pts) What is/are the most likely source(s) of this fiber if any?

Expected Answer: Cowboy Sam's jeans and Farmer Joe's overalls

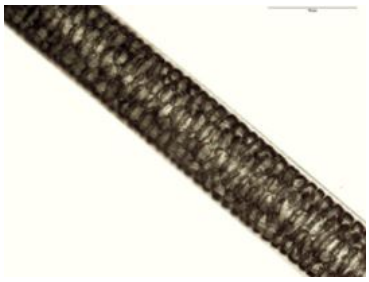
You find three different types of hair near the chicken coop. Farmer Joe claims that the hairs were from his chicken, but you don't think so.

29. (1.00 pts) What is the identity of this hair?



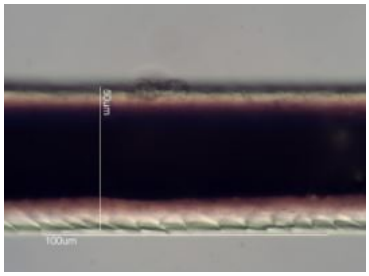
Expected Answer: Human

30. (1.00 pts) What is the identity of this hair?



Expected Answer: Squirrel

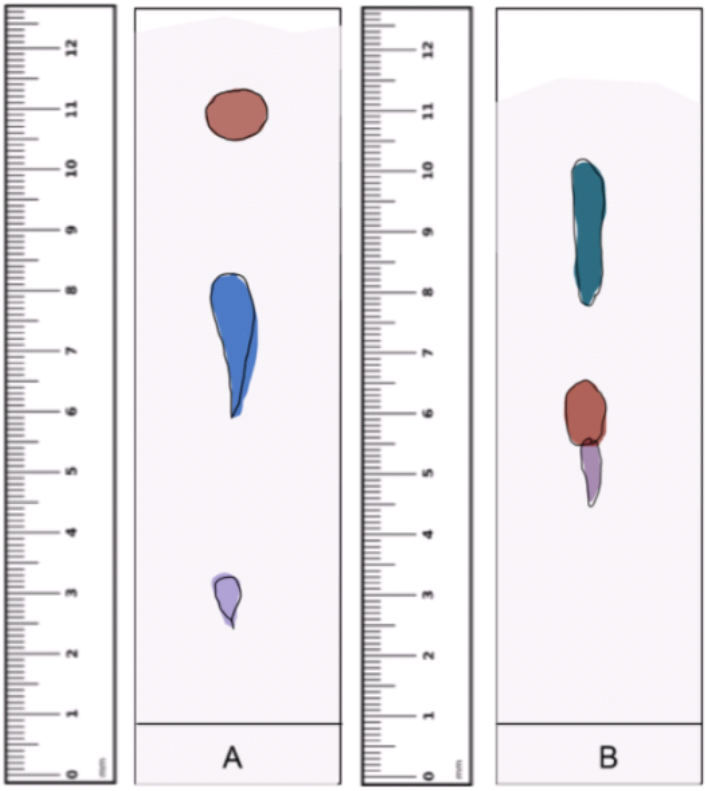
31. (1.00 pts) What is the identity of this hair?



Expected Answer: Cow

You decide to perform a chromatography on the ransom note. Chromatogram A shows the chromatography done on the ransom note ink and Chromatogram B is from a receipt Farmer Joe had lying around.

32. (3.00 pts) Calculate the Rf for each spot in the chromatograms below.



Expected Answer: Accept any answer within these ranges: A: Red: 0.83-0.93 Blue: 0.51-0.61 Purple: 0.19-0.29 B Teal: 0.76-0.86 Red: 0.50-0.60 Purple: 0.40-0.50 Each one off is -.5 points

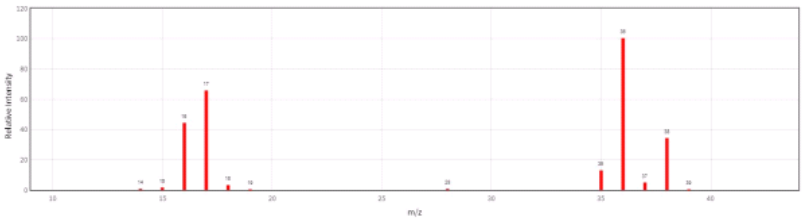
33. (1.00 pts) Whose pen is depicted in chromatogram A?

Expected Answer: Farmer Joe's, could also have been used by Cowboy Sam or Jesse (Pen B)

34. (1.00 pts) Whose pen is depicted in chromatogram B?

Expected Answer: Door to Door Salesman David's (Pen C)

35. (1.00 pts)
You were able to find a partial shoe print at the chicken coop. In this shoe print, they found traces of a chemical, but not enough to do a full powder analysis. Instead, they took a mass spectrum which is shown here.



What is measured on the x-axis of the mass spectrum?

Expected Answer: Mass to charge ratio

36. (1.00 pts) What is the x-axis value of the base peak in this spectrum?

Expected Answer: 36

37. (1.00 pts) What is the mass of the sample in the mass spectrum?

Expected Answer: 53 g/mol

38. (1.00 pts) What is the identity of the chemical in the mass spectrum?

Expected Answer: Ammonium Chloride

39. (1.00 pts) What is/are the most likely source(s) of the chemical in the mass spectrum?

Expected Answer: Cowboy Sam's fertilizer and Door to Door Salesman David's fertilizer Each one is .5 points

40. (1.00 pts) How are the peaks at 36 and 38 related to each other (i.e. what about the molecule results in these two peaks being two apart)?

Expected Answer: The two most common isotopes of chlorine, 35 and 37, are two amu apart in mass. The extra 1 amu is from hydrogen.

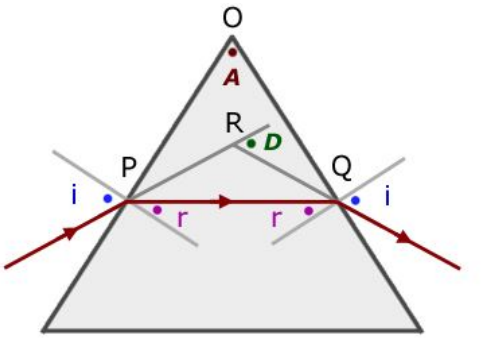
41. (1.00 pts)
You find a glass shard near the chicken coop. At first glance, it looks rectangular, and you shine a laser at it through air (n = 1.00) at an angle of incidence of 30.0 degrees. The angle of refraction inside the shard of glass is 19.5 degrees, but since the shard is so thin, you're not sure if this measurement is actually accurate.

Let's assume the best case: your measurements are 100% accurate. Based on this data, what would be the index of refraction of the glass? Round to the nearest hundredths place.

Hint: in optics, the convention is for angles of refraction/incidence to be measured from the line perpendicular to the surface of the object.

Expected Answer: n = 1.50

42. (1.00 pts)
However, you're a star investigator for a reason, and you're going to make sure you get some accurate results. After looking closer, you realize that the shard of glass is actually a thin triangular prism. As a result, you measure the minimum deviation angle, which is a lot easier to determine accurately for thin prisms.



Suppose the apex angle of the shard of glass is 10 degrees and its minimum deviation angle is 5.22547 degrees. What is the index of refraction of this shard of glass? Round to the nearest hundredths place.

Expected Answer: n = 1.52

43. (1.00 pts) You have lifted several fingerprints on the chicken coop door. Identify what types of fingerprints they are below and who they can potentially belong to.

(The left Fingerprint is Fingerprint 1 and the right Fingerprint is Fingerprint 2)

What is the type of fingerprint 1?

Expected Answer: Tented Arch

44. (1.00 pts) Whose fingerprint is fingerprint 1?

Expected Answer: Cowboy Sam

45. (1.00 pts) What type of fingerprint is fingerprint 2?

Expected Answer: Central pocket whorl

46. (1.00 pts) Whose fingerprint is fingerprint 2?

Expected Answer: Jesse

47. (1.00 pts) According to the Henry Classification System, which of the following is not a basic fingerprint pattern?

- (●) A) Swirl
- ( ) B) Loop
- ( ) C) Whirl
- ( ) D) Arch

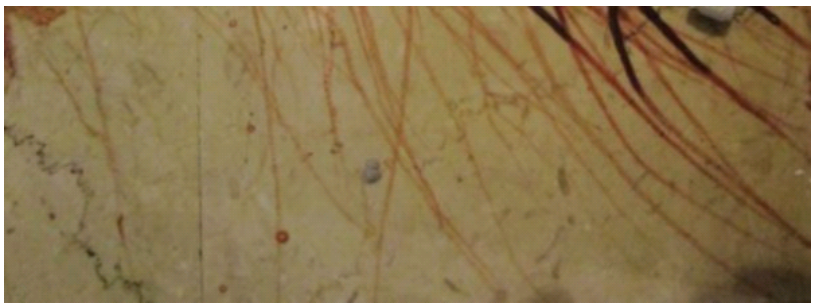
48. (1.00 pts) What fingerprint lifting method is used to get prints off of non-porous surfaces, especially on ones that are greasy?

Expected Answer: Sudan Black

49. (1.00 pts) Are fingerprints alone reliable enough to incriminate a suspect for a crime?

- ( ) A) Yes
- (●) B) No

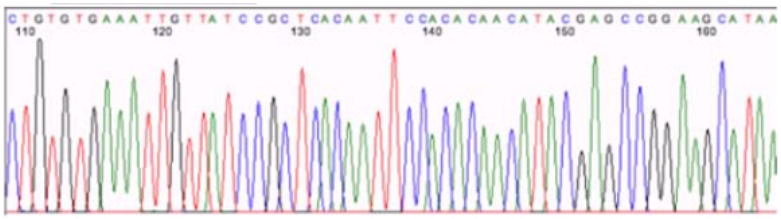
50. (1.00 pts) Around the chicken coop, linear bloody stripes were found on the ground radiating in all directions (see picture below).



This may indicate evidence of:

- ( ) A) Blunt force trauma
- (●) B) Maggot-induced decomposition
- ( ) C) A gunshot wound
- ( ) D) Movement or dragging of the body after death

51. (1.00 pts)
A non-victim DNA sample was found at the scene and was sequenced for a telltale Single Nucleotide Polymorphism (SNP) at position 132 in Gene X, producing the following chromatogram:



Assuming the gene begins transcription at position 1, based on the properties of codons and translation, how likely is this SNP to actually manifest in a physical difference in the suspect?

- A) Highly likely
- B) Moderately likely
- C) Unlikely

52. (1.00 pts)
Position 132 is typically cytosine. The telltale SNP of interest involves the change of cytosine to a purine base. Is this SNP present in this sample based on the chromatogram?

- A) Yes
- B) No

You then decided that the DNA sample was useless in your investigation and you carried on.

53. (1.00 pts) You found two blood samples near the chicken coop door and decided to perform blood tests on them.

Sample	Anti-B	Anti-A	Anti-Rh
Sample 1	clumps	clumps	no clumps
Sample 2	no clumps	clumps	clumps

What's the blood type of Sample A?

Expected Answer: AB-

54. (1.00 pts) Whose blood is this?

Expected Answer: Farmer Joe

55. (1.00 pts) What's the blood type of Sample B?

Expected Answer: A+

56. (1.00 pts) Whose blood is this?

Expected Answer: Cowboy Sam

57. (1.00 pts) What blood type is known as the universal donor?

Expected Answer: O-

58. (1.00 pts) What blood type is known as the universal recipient?

Expected Answer: AB+

59. (1.00 pts) Can parents of blood types AB and O have a child that has a blood type of O?

- A) Yes
- B) No

60. (50.00 pts) Famer Joe is getting impatient and he didn't call you for nothing! Who hennapped his prized chicken and what evidence leads you to believe so?

Expected Answer: 10 pts per suspect, 2 for identifying, 6 for evidence, 2 for motive each Cowboy Sam (guilty, ammonium chloride (fertilizer), mass spec, PP (bottle), cotton (shirt), hair (cow/human), blood type/fingerprint, farmer joe doesn't like him) Farmer Joe (possibly guilty, boric acid (insecticide), cotton (denim), hair (bat/human), blood type, chromatography (ransom), insurance money) Plumber Mike (not guilty, cornstarch (baby powder), PVC (pipes), fiber (nylon), hair (squirrel/human), no motive) Horse Girl Jesse (not guilty, sucrose (sugar cubes), fiber (nylon), hair (human), fingerprint, no motive) Salesman David (not guilty, ammonium chloride (fertilizer), chromatography (receipt), no hair (bald), no motive)

Congratulations on completing the exam! If you have any feedback about any of the exams at this tournament, please let us know through this form: https://tinyurl.com/utreg21feedback