C - Forensics C 2020-2021 - BEARSO - 10-24-2020

Remy crawls into Gusteau's one morning to find his cherished ratatouille recipe has been stolen. The recipe was in a glass cookie jar which is now broken on the counter. It is up to you to analyze all the evidence found at the scene to determine who committed this crime and who wants to bring Gusteau's down.

Here (https://docs.google.com/document/d/1MOB0OPIaB6Bqz25yUFIi3qYJNBi42mwY20B19nKBZvU/edit?usp=sharing) is a document containing supplemental information and images that could not be inserted into the test without loss of clarity. These will be crucial to your identification of many crime scene samples and your understanding of the suspects. There are also images not related to the crime scene evidence, but you will still be asked questions about these images.

Below is a table containing the qualitative analysis test results for the 10 powder samples. The same information is including in the supplemental information document.

Sample	Solubility	Conductivity	pH	Flame test	HCl	NaOH	Benedict's	Iodine
A	Yes	Yes	7	Yellow	No reaction	No reaction	No reaction	No reaction
B	Yes	Yes	9	Yellow	Bubbles	No reaction	No reaction	No reaction
C	Yes	No	7	N/A	No reaction	No reaction	No reaction	No reaction
D	No	No	7	N/A	No reaction	No reaction	No reaction	Dark purple
E	Yes	Yes	9	Yellow	No reaction	No reaction	No reaction	No reaction
F	Yes	Yes	7	Purple	No reaction	No reaction	No reaction	No reaction
G	No	No	7	N/A	Bubbles	No reaction	No reaction	No reaction
H	Yes	Yes	6	Green	No reaction	No reaction	No reaction	No reaction
I	Yes	Yes	7	N/A	No reaction	White ppt	No reaction	No reaction
J	Yes	Yes	11	Yellow	Bubbles	No reaction	No reaction	No reaction

The following 20 questions will relate to your identification of these powders. For identification of the powders, put the name of the powder in the first blank and its chemical formula in the second blank.

1. (5.00 pts) What is the identity of powder sample A?

sodium chloride | NaCl

2. (5.00 pts) Which suspect(s) is(are) implicated by powder sample A?

(Mark **ALL** correct answers)

- [x] A) Alfredo Linguini
- [x] B) Colette Tatou
- [x] C) Skinner
- [x] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

3. (5.00 pts) What is the identity of powder sample B?

sodium bicarbonate | NaHCO3

4. (5.00 pts) Which suspect(s) is(are) implicated by powder sample B?

(Mark **ALL** correct answers)

- [x] A) Alfredo Linguini
- [x] B) Colette Tatou
- [x] C) Skinner
- [x] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

5. (5.00 pts) What is the identity of powder sample C?

sucrose | C12H22O11

6. (5.00 pts) Which suspect(s) is(are) implicated by powder sample C?

(Mark **ALL** correct answers)

- [x] A) Alfredo Linguini
- [x] B) Colette Tatou
- [x] C) Skinner
- [x] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

7. (5.00 pts) What is the identity of powder sample D?

cornstarch | C27H48O20

8. (5.00 pts) Which suspect(s) is(are) implicated by powder sample D?

(Mark **ALL** correct answers)

- [x] A) Alfredo Linguini
- [x] B) Colette Tatou
- [x] C) Skinner
- [x] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

9. (5.00 pts) What is the identity of powder sample E?

sodium acetate | NaC2H3O2

10. (5.00 pts) Which suspect(s) is(are) implicated by powder sample E?

(Mark **ALL** correct answers)
- [x] A) Alfredo Linguini
- [x] B) Colette Tatou
- [x] C) Skinner
- [x] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

11. (5.00 pts) What is the identity of powder sample F?

potassium chloride | KCl

12. (5.00 pts) Which suspect(s) is(are) implicated by powder sample F?

(Mark **ALL** correct answers)
- [ ] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [ ] C) Skinner
- [x] D) Horst
- [x] E) Anton Ego
- [ ] F) None

13. (5.00 pts) What is the identity of powder sample G?

calcium carbonate | CaCO3

14. (5.00 pts) Which suspect(s) is(are) implicated by powder sample G?

(Mark **ALL** correct answers)
- [ ] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [ ] C) Skinner

- [x] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

15. (5.00 pts) What is the identity of powder sample H?

boric acid | H3BO3

16. (5.00 pts) Which suspect(s) is(are) implicated by powder sample H?

(Mark **ALL** correct answers)
- [x] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [x] C) Skinner
- [ ] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

17. (5.00 pts) What is the identity of powder sample I?

magnesium sulfate | MgSO4

18. (5.00 pts) Which suspect(s) is(are) implicated by powder sample I?

(Mark **ALL** correct answers)
- [x] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [ ] C) Skinner
- [ ] D) Horst
- [x] E) Anton Ego
- [ ] F) None

19. (5.00 pts) What is the identity of powder sample J?

sodium carbonate | Na2CO3

20. (5.00 pts) Which suspect(s) is(are) implicated by powder sample J?

(Mark **ALL** correct answers)
- [ ] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [ ] C) Skinner
- [ ] D) Horst
- [ ] E) Anton Ego
- [x] F) None

The following 8 questions will pertain to your identification of the 4 crime scene plastic samples. Please answer with the abbreviated form of the plastic name for the identification questions.

21. (5.00 pts) What is the identity of plastic sample 1?

ldpe

22. (5.00 pts) Which suspect(s) is(are) implicated by plastic sample 1?

(Mark **ALL** correct answers)

- [x] A) Alfredo Linguini
- [x] B) Colette Tatou
- [x] C) Skinner
- [x] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

23. (5.00 pts) What is the identity of plastic sample 2?

hdpe

24. (5.00 pts) Which suspect(s) is(are) implicated by plastic sample 2?

(Mark **ALL** correct answers)

- [x] A) Alfredo Linguini
- [x] B) Colette Tatou
- [x] C) Skinner
- [x] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

25. (5.00 pts) What is the identity of plastic sample 3

pc

26. (5.00 pts) Which suspect(s) is(are) implicated by plastic sample 3?

(Mark **ALL** correct answers)

- [ ] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [ ] C) Skinner
- [ ] D) Horst
- [x] E) Anton Ego
- [ ] F) None

27. (5.00 pts) What is the identity of plastic sample 4?

pp

28. (5.00 pts) Which suspect(s) is(are) implicated by plastic sample 4?

(Mark **ALL** correct answers)

- [x] A) Alfredo Linguini
- [x] B) Colette Tatou
- [x] C) Skinner
- [x] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

The following 8 questions will relate to your identification of the 4 crime scene fiber samples.

29. (5.00 pts) What is the identity of fiber sample 1?

cotton

30. (5.00 pts) Which suspect(s) is(are) implicated by fiber sample 1?

(Mark **ALL** correct answers)

- [x] A) Alfredo Linguini
- [x] B) Colette Tatou
- [x] C) Skinner
- [x] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

31. (5.00 pts) What is the identity of fiber sample 2?

wool

32. (5.00 pts) Which suspect(s) is(are) implicated by fiber sample 2?

(Mark **ALL** correct answers)

- [ ] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [ ] C) Skinner
- [ ] D) Horst
- [x] E) Anton Ego
- [ ] F) None

33. (5.00 pts) What is the identity of fiber sample 3?

silk

34. (5.00 pts) Which suspect(s) is(are) implicated by fiber sample 3?

(Mark **ALL** correct answers)

- [ ] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [ ] C) Skinner
- [ ] D) Horst
- [ ] E) Anton Ego
- [x] F) None

35. (5.00 pts) What is the identity of fiber sample 4?

polyester

36. (5.00 pts) Which suspect(s) is(are) implicated by fiber sample 4?

(Mark **ALL** correct answers)

- [ ] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [ ] C) Skinner
- [ ] D) Horst
- [ ] E) Anton Ego
- [x] F) None

The following 6 questions relate to your identification of the 3 crime scene hair samples.

37. (5.00 pts) To which species does hair sample 1 belong?

- (●) A) Human
- ( ) B) Bat
- ( ) C) Cow
- ( ) D) Squirrel
- ( ) E) Horse

38. (5.00 pts) Which suspect(s) is(are) implicated by hair sample 1?

(Mark **ALL** correct answers)

- [ ] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [x] C) Skinner
- [ ] D) Horst

- [x] E) Anton Ego
- [ ] F) None

39. (5.00 pts) To which species does hair sample 2 belong?

- (●) A) Human
- ( ) B) Bat
- ( ) C) Cow
- ( ) D) Squirrel
- ( ) E) Horse

40. (5.00 pts) Which suspect(s) is(are) implicated by hair sample 2?

(Mark **ALL** correct answers)

- [ ] A) Alfredo Linguini
- [x] B) Colette Tatou
- [ ] C) Skinner
- [ ] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

41. (5.00 pts) To which species does hair sample 3 belong?

- ( ) A) Human
- (●) B) Bat
- ( ) C) Cow
- ( ) D) Squirrel
- ( ) E) Horse

42. (5.00 pts) Which suspect(s) is(are) implicated by hair sample 3?

(Mark **ALL** correct answers)

- [ ] A) Alfredo Linguini
- [x] B) Colette Tatou
- [ ] C) Skinner
- [ ] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

The following 2 questions will relate to your identification of the crime scene fingerprints.

43. (5.00 pts) Which suspect left fingerprint 1?

- ( ) A) Alfredo Linguini

B) Colette Tatou
C) Skinner
D) Horst
E) Anton Ego
F) None

44. (5.00 pts) Which suspect left fingerprint 2?

A) Alfredo Linguini
B) Colette Tatou
C) Skinner
D) Horst
E) Anton Ego
F) None

For the following 5 questions, assume all prints are taken from the right hands of the suspects.

45. (5.00 pts) What type of fingerprint does Alfredo Linguini have?

A) Radial loop
B) Ulnar loop
C) Plain whorl
D) Central pocket whorl
E) Accidental whorl
F) Double loop whorl

46. (5.00 pts) What type of fingerprint does Colette Tatou have?

A) Radial loop
B) Ulnar loop
C) Plain whorl
D) Central pocket whorl
E) Accidental whorl
F) Double loop whorl

47. (5.00 pts) What type of fingerprint does Skinner have?

A) Radial loop
B) Ulnar loop
C) Plain whorl
D) Central pocket whorl
E) Accidental whorl
F) Double loop whorl

48. (5.00 pts) What type of fingerprint does Horst have?

- A) Radial loop
- B) Ulnar loop
- C) Plain whorl
- D) Central pocket whorl
- E) Accidental whorl
- F) Double loop whorl

49. (5.00 pts) What kind of fingerprint does Anton Ego have?

- A) Radial loop
- B) Ulnar loop
- C) Plain whorl
- D) Central pocket whorl
- E) Accidental whorl
- F) Double loop whorl

6 blood spatters were found at the crime scene. It was determined that all six spatters originated from the same horizontal position, however it is not clear whether all these spatters originated from the same point in 3D space. Below is a table containing the dimensions of each blood spatter and its distance from the point of horizontal convergence.

Spatter	1	2	3	4	5	6
Width (cm)	0.18	0.38	0.07	0.65	1.08	0.24
Length (cm)	0.36	0.54	0.27	0.75	1.1	0.64
Distance (m)	2.07	1.20	4.48	0.69	0.17	1.98

In the following 6 questions, calculate the height from which each spatter originated, in meters, to 1 decimal place. You only need to submit your numerical answer.

50. (5.00 pts) From what height did spatter 1 originate?

1.2

51. (5.00 pts) From what height did spatter 2 originate?

1.2

52. (5.00 pts) From what height did spatter 3 originate?

1.2

53. (5.00 pts) From what height did spatter 4 originate?

1.2

54. (5.00 pts) From what height did spatter 5 originate?

0.8

55. (5.00 pts) From what height did spatter 6 originate?

0.8

56. (5.00 pts) Did all the blood spatters originate from the same height?

- A) Yes
- B) No

57. (5.00 pts)
A piece of the broken glass cookie jar has a right angled corner, such that two adjacent, flat faces are perpendicular. To determine the index of refraction of the glass, a laser is pointed at one face at an angle of 35.26 degrees to the normal. It refracts inside the glasses and just barely experiences total internal reflection off the adjacent, perpendicular face. Calculate the index of refraction of the glass to 2 decimal places.

1.15

Below is a table containing the results of the blood typing tests done on the 2 crime scene blood samples. An X represents an agglutination reaction between the sample and the specified antibodies.

Sample	Anti-A	Anti-B	Anti-D
1		X	
2	X		X

58. (5.00 pts) What is the blood type of sample 1? Select the correct ABO designation and Rh factor.

(Mark **ALL** correct answers)

- [ ] A) A
- [x] B) B
- [ ] C) AB
- [ ] D) O
- [ ] E) +
- [x] F) -

59. (5.00 pts) Which suspect(s) is(are) implicated by blood sample 1?

(Mark **ALL** correct answers)

- [ ] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [ ] C) Skinner
- [x] D) Horst
- [ ] E) Anton Ego
- [ ] F) None

60. (5.00 pts) What is the blood type of sample 2? Select the correct ABO designation and Rh factor.

(Mark **ALL** correct answers)

- [x] A) A
- [ ] B) B
- [ ] C) AB
- [ ] D) O
- [x] E) +
- [ ] F) -

61. (5.00 pts) Which suspect(s) is(are) implicated by blood sample 2?

(Mark **ALL** correct answers)

- [ ] A) Alfredo Linguini
- [ ] B) Colette Tatou
- [ ] C) Skinner
- [ ] D) Horst
- [x] E) Anton Ego
- [ ] F) None

The following questions are not related to the crime scenario. Your analysis of the crime is the last question, which is of course still related to the crime scenario, however there will be no further questions related to crime scene evidence.

62. (5.00 pts) Which form of iodine is responsible for the dark purple complex with starch?

- ○ A) I_2
- ○ B) I^-
- ◉ C) I_3^-

63. (7.00 pts)
One of the more prominent spectral emission lines of sodium has a wavelength of 589.0 nm. Calculate the energy of a photon with this wavelength in Joules to 4 sig figs, in scientific notation. (if you can't format exponents, simply use the E notation)

Expected Answer: 3.375E-19

64. (5.00 pts)
Fill in the missing coefficients to balance the following reaction. The coefficients may not be completely reduced. If you have a non-integer coefficient, input your answer as a fraction.

1 HCl + ____ Na2CO3 -> _____ H2O + _____ CO2 + 1 NaCl

1/2 | 1/2 | 1/2

65. (5.00 pts)
Fill in the missing coefficients to balance the following reaction. The coefficients may not be completely reduced. If you have a non-integer coefficient, input your answer as a fraction.

____ CH3COOH + 3 NaHCO3 -> 3 NaCH3COO + _____ H2O + _____ CO2

3 | 3 | 3

66. (6.00 pts) Which of the following is(are) component(s) of Benedict's solution?

(Mark **ALL** correct answers)

- [x] A) Sodium carbonate
- [ ] B) Sodium hydroxide
- [ ] C) Sodium sulfate
- [x] D) Copper(II) sulfate
- [ ] E) Copper(I) sulfate
- [x] F) Sodium citrate

67. (6.00 pts) Why are some water soluble solids conductive while others are non-conductive?

Expected Answer: To be conductive, the solid must be able to dissociate into ions that can carry electric current. Not all soluble solids can dissociate like this.

68. (7.00 pts) How would one tell if a solution contained carbonate or bicarbonate ions, and what property of the ions makes this possible?

Expected Answer: pH. The carbonate ion is a stronger base because of its greater charge, more able to accept a proton from water/another acid.

69. (3.00 pts) Which of the following plastics are commonly synthesized by Fischer esterification?

(Mark **ALL** correct answers)

- [x] A) PETE
- [ ] B) HDPE
- [ ] C) PP
- [ ] D) PMMA
- [ ] E) PC
- [ ] F) None of the above

70. (10.00 pts)
HDPE and LDPE are both polymerized by addition from the same monomer, yet they have different physical properties. From what monomer are they synthesized, what chemical or structural difference accounts for the difference in properties, and how is this chemical or structural difference created during synthesis?

Expected Answer: Ethylene, LDPE is branched, a special catalyst is used for HDPE production that promotes linear chain growth, +1 bonus for Ziegler-natta catalyst

71. (3.00 pts) From what monomer are vegetable fibers made?

Cellulose

72. (3.00 pts) What protein is silk fiber primarily composed of?

fibroin

73. (6.00 pts) What are the three phases of hair growth, in order?

anagen | catagen | telogen

74. (6.00 pts) What are the three layers of a hair, from inside to outside?

Medulla | cortex | cuticle

75. (3.00 pts) What is the origin of the name "condensation polymerization?"

Expected Answer: Polymers synthesized by condensation release H2O as a product of the reaction

76. (9.00 pts) What are the Rfs of the red, blue, and then green compounds? Answer to 1 decimal place.

0.9 | 0.6 | 0.2

77. (10.00 pts) If the stationary phase is polar and the mobile phase is nonpolar, will a a given compound have a higher or lower Rf than a different, more polar compound?

- (●) A) Higher
- ( ) B) Lower

78. (10.00 pts)
In HPLC with a common polar stationary phase, compounds A, B, and C eluted from the column in the order A first, then C, and last B. In a reverse phase HPLC column, the stationary phase is nonpolar and the solvent is polar. In what order will these compounds elute from the column?

- ( ) A) A, B, C
- ( ) B) A, C, B
- ( ) C) B, A, C

- [x] D) B, C, A
- [ ] E) C, A, B
- [ ] F) C, B, A

79. (15.00 pts) In a mass spectrum, a peak with what m/z is a common indicator of a primary alcohol? What is the formula of this fragment?

Expected Answer: m/z 31 indicates a primary alcohol. CH2OH+ (+ not necessary)

80. (20.00 pts)
Why are there more peaks in the mass spectrum for diethyl ether than there are in the mass spectrum for 1-methoxypropane, even though the two compounds are isomers?

Expected Answer: There are a greater number of stable fragments of diethyl ether because you can have alpha and beta cleavage products. In 1-methoxypropane, there are 2 bonds that can be cleaved for alpha cleavage but only 1 beta cleavage, and the beta cleavage product has smaller alkyl groups than the beta cleavage fragments of diethyl ether, so the diethyl ether beta fragments can better stabilize the positive charge on the fragment.

81. (15.00 pts) What is the name of the tallest peak in a mass spectrum? Why is this peak larger than all the others?

Expected Answer: Base peak, the most stable fragment of the molecule, so it's the most likely product of fragmentation and ionization

82. (10.00 pts) What are the genotypes of individuals 1, 2, and 3 in the pedigree? Refer to the three alleles as A, B, and I. Use X if you cannot determine an allele from the pedigree.

BX | AX | AI

83. (5.00 pts) What color are the fingerprints developed by ninhydrin?

Expected Answer: Ruhemann's purple, half points for just purple

84. (5.00 pts) What is the minimum number of minutiae required for the AFIS system?

- [ ] A) 4
- [x] B) 6

C) 8

D) 10

E) 12

F) 14

85. (3.00 pts) What type(s) of fingerprints need no visualization techniques?

(Mark **ALL** correct answers)

A) Latent

B) Patent

C) Plastic

D) Visible

E) Invisible

F) Bloody

86. (5.00 pts) What is the name of the condition of having no fingerprints?

Adermatoglyphia

87. (225.00 pts) Write your analysis of the crime here. Include all details you think are relevant.

Expected Answer: Consult scoring guide

This concludes the BEARSO invitational Forensics test.