

Science Olympiad
Fairfax Invitational Competition
Forensic Science

Team Number: _____

Team/School Name: _____

Student Names (First & Last):

1. _____

2. _____

Total Points Possible: 100

Total Points Earned: _____

Rank: _____

Tiebreaker Needed (Circle): Y / N

Explain:

Rules violations (Circle): Y / N **Explain:**

Crime Scene Scenario:

On the morning of January 5th a home was burglarized. The homeowner returned to find their front window broken and electronics missing. The homeowners immediately called the police. The police obtained shoe impressions found near the broken window and collected a blood sample found on a piece of broken glass. Police also collected a note, hair, fiber, pen and powder found inside the house. A pen was also collected outside of the window on the ground. Three suspects were identified and police collected DNA, a hair, a fibers, a powder, a pen and shoe impressions from each person. Suspect 1 is Amanda, Suspect 2 is Max and Suspect 3 is Shawn. The crime scene evidence was analyzed by the crime lab and the results are listed below. It is your job to analyze and compare the suspect evidence with the results of the crime scene evidence.

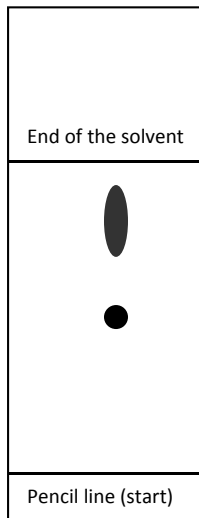
Crime Scene Evidence

- White powder: potassium chloride
- Hair: Human
- Fiber: polyester
- DNA profile

Loci	F/M	D3S1358	vWA	FGA	D8S1179	D21S11	D18S51	D5S818	D13S317	D7S820
Crime Scene DNA	XY	15 17	17 18	18 19 20 24	13 14 15	29 30 31.2 32.2	16 18 23 24	11	10 11	9 12 13

- Ink chromatogram:

Impression:



Part A: Qualitative Analysis (20%)

Directions: Use the materials provided at station A along with the materials you brought to determine the identity of the unknown powders. Substances to identify: sodium acetate, sodium chloride, sodium hydrogen carbonate (sodium bicarbonate), sodium carbonate, lithium chloride, potassium chloride, calcium nitrate, calcium sulfate, calcium carbonate, cornstarch, glucose, sucrose, magnesium sulfate, boric acid and ammonium chloride. There are no mixtures. Write the name of each unknown powder on the line provided below. (5 pts each)

powder 4 _____

powder 5 _____

powder 6 _____

____ Which chemical reacts with Benedict's Solution and what color does it turn? (1 pt)

- a. Glucose, blue
- b. Glucose, orange
- c. Copper Sulfate, blue
- d. Sucrose, orange

____ What is a common application or source of calcium carbonate? (1 pt)

- a. Heat packs
- b. Limestone
- c. Fertilizer
- d. Meat preservatives

____ What is a common application for sodium carbonate? (1 pt)

- a. Deicer
- b. Baking Soda
- c. Laundry Softener
- d. Cement

____ What color in a flame test will potassium chloride typically give off? (1 pt)

- a. Purple
- b. Yellow
- c. Red
- d. Green

____ Which powder is hygroscopic? (1 pt)

- a. calcium nitrate
- b. calcium carbonate
- c. sodium carbonate
- d. magnesium sulfate

____ What gas is produced when calcium carbonate is reacted with hydrochloric acid? (1 pt)

- a. water vapor
- b. hydrogen gas
- c. carbon dioxide
- d. carbonate gas

____ Which powder has a basic pH when dissolved in distilled water? (1 pt)

- a. calcium nitrate
- b. calcium carbonate
- c. sodium carbonate
- d. magnesium sulfate

Part B: Plastic (20% for all of Part B)

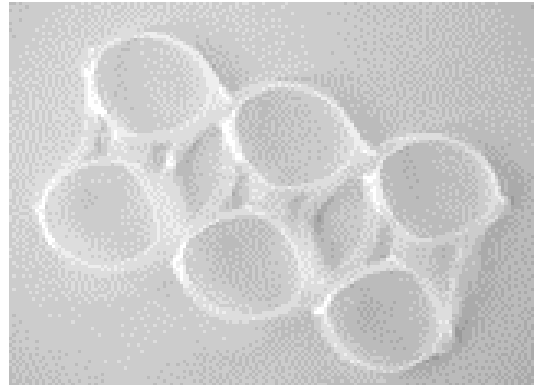
Content Questions: Write your answer (A-D) on the line provided below next to each question.

_____ Which of the following polymers will sink in distilled water? (1 point)

- a. HDPE
- b. LDPE
- c. PP
- d. PC

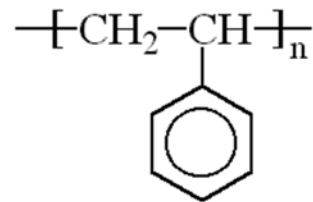
_____ Which of the following polymers is used in plastic wrap and the plastic shown to the right? (1 point)

- a. Non-expanded PS
- b. LDPE
- c. PP
- d. PC



_____ Which polymer is composed of repeating monomer units shown to the right? (1 point)

- a. PETE
- b. Non-expanded PS
- c. PP
- d. PC



_____ Which of the following polymers is recycled under recycling code #1? (1 point)

- a. PVC
- b. PETE
- c. HDPE
- d. PC



Part B: Hair (20% for all of Part B)

Directions: Identify the species of the hair recovered from each suspects.

Content Questions: Write your answer (A-E) on the line provided below next to each question.

_____ What is the species of the hair recovered from suspect 1? (2 points)

- a. Human
- b. Bat
- c. Horse
- d. Cow
- e. Squirrel

_____ What is the species of the hair recovered from suspect 2? (2 points)

- a. Human
- b. Bat
- c. Horse
- d. Cow
- e. Squirrel

_____ What is the species of the hair recovered from suspect 3? (2 points)

- a. Human
- b. Bat
- c. Horse
- d. Cow
- e. Squirrel

_____ What species' hair is represented in the picture? (1 point)

- a. Squirrel
- b. Horse
- c. Cow
- d. Bat



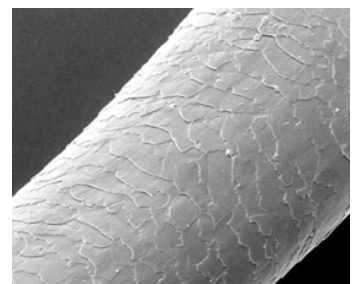
_____ What is the medulla pattern of the following hair sample? (1 point)

- a. Continuous
- b. Fragmented
- c. Absent
- d. Coronal



_____ What type of scale pattern is this and what species does it belong to? (1 point)

- a. Imbricate, bat
- b. Spinous, cow
- c. Imbricate, human
- d. Coronal, bat



Part B: Fiber (20% for all of Part B)

Directions: Determine the identity of the fibers recovered from the three suspects. The fibers may be analyzed using microscopes and/or the burn test.

Content Questions: Write your answer (A-E) on the line provided below next to each question.

_____ What is the composition of the fiber recovered from suspect 1? (3 points)

- a. Cotton
- b. Nylon
- c. Polyester
- d. Wool
- e. Spandex

_____ What is the composition of the fiber recovered from suspect 2? (3 points)

- a. Cotton
- b. Nylon
- c. Polyester
- d. Wool
- e. Spandex

_____ What is the composition of the fiber recovered from suspect 1? (3 points)

- a. Cotton
- b. Nylon
- c. Polyester
- d. Wool
- e. Spandex

_____ Which of the following is correctly matched? (1 point)

- a. Wool – natural – animal source
- b. Linen – synthetic
- c. Spandex – natural – plant source
- d. Cotton – regenerated

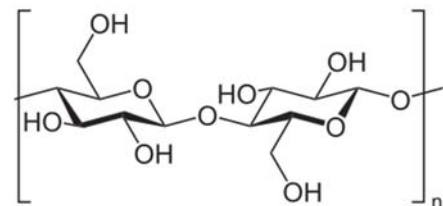
_____ What fiber matches the following results? (1 point)

Not self-extinguishing, Odor of a burning campfire, Creates a grey ash

- a. Wool
- b. Nylon
- c. Spandex
- d. Cotton

_____ What fiber is a polymer of the repeating monomer shown to the right? (1 point)

- a. Nylon
- b. Spandex
- c. Cotton
- d. Polyester

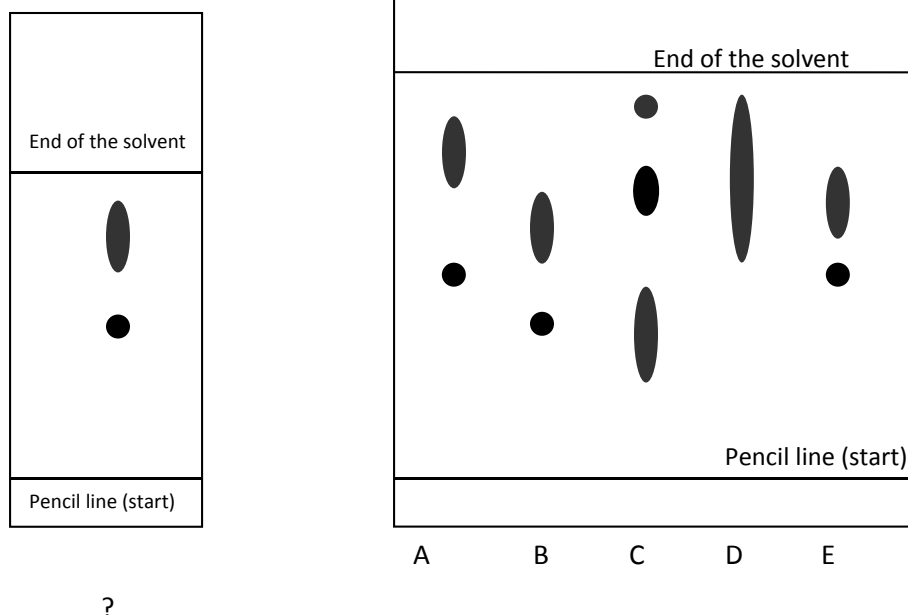


_____ A synthetic fiber is defined as a fiber that is: (1 point)

- a. Made from animal hair
- b. Man made from natural fibers such as rayon.
- c. Man made using the waste from the oil and coal industry such as polyester
- d. Extracted from plant material

Part C: Chromatography (15%)

Directions: Examine the two chromatograms below. The “?” ink sample is the ink sample recovered from the note found at the crime scene. Sample A ink was from a pen found with suspect 1. Sample B ink was from a pen found with suspect 2. Sample C ink was from a pen found with suspect 3. Sample D ink was from a pen found outside of the crime scene near the window. Sample E ink was from a pen found at the crime scene.



Content Questions: Write your answer (A-E) on the line provided below next to each question.

_____ What are the R_f values of the crime scene ink sample? (3 points)

- a. .5 and .8
- b. .48 and 0.7
- c. .45 and .85
- d. .3 and .7

_____ Which ink sample has the same R_f values as the crime scene ink sample? (2 points)

- a. A
- b. B
- c. C
- d. D
- e. E

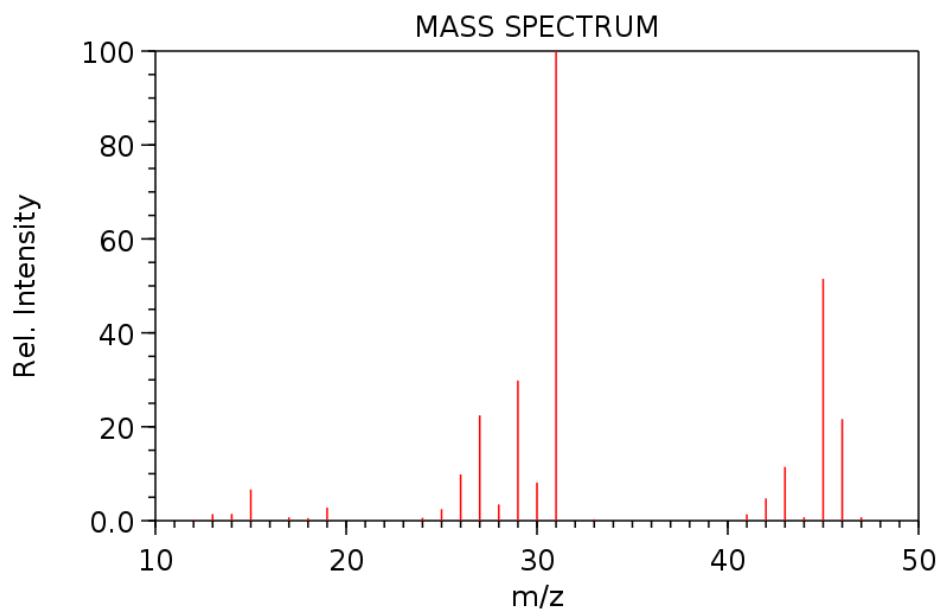
_____ In paper chromatography, what is the stationary phase? (1 point)

- a. Silica or alumina
- b. solvent
- c. paper
- d. beaker

_____ In paper chromatography, what is the mobile phase? (1 point)

- a. Silica or alumina
- b. solvent
- c. paper
- d. beaker

Directions: Answer the following questions using the mass spectrum below.

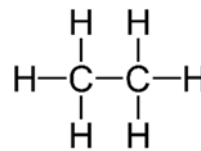
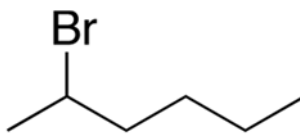
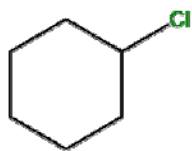
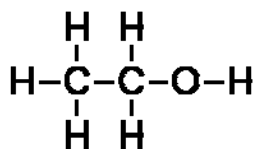


NIST Chemistry WebBook (<http://webbook.nist.gov/chemistry>)

What is the m/z of the base peak? _____ (1 point)

What is the mass of the molecule shown in the spectrum above? _____ (1 point)

Which of the following is a possible structure of the molecule shown in the spectrum above? (1 point) (circle the molecule below)



Part D: DNA (15% for all of Part D)

- Electropherograms of the DNA extracted from the three suspect's blood.
- Chart of loci and alleles obtained from the DNA recovered from the blood at the crime scene. (see below)

Loci	F/M	D3S1358	vWA	FGA	D8S117	D21S11	D18S51	D5S818	D13S317	D7S820
Crime Scene DNA	XY	15 17	17 18	18 19 20 24	13 14 15	29 30 31.2 32.2	16 18 23 24	11	10 11	9 12 13

Content Questions: Write your answer (A-E) on the line provided below next to each question.

_____ Compare the DNA profile from the crime scene to the 3 suspects. Who's DNA was found at the crime scene? (3 points)

- a. Suspect 1 only
- b. Suspect 2 only
- c. Suspect 3 only
- d. Suspect 2 and 3 mixed profile
- e. Suspect 1 and 2 mixed profile

_____ Polymerase Chain Reactions (PCR) is a technique used to: (1 point)

- a. To amplify DNA samples
- b. To copy the entire human genome
- c. To isolate a region of DNA
- d. Both a and c

_____ For the sequence ATTGGACTACTACTACTACTACGGTA how many short/variable tandem repeats are present? (1 point)

- a. 4
- b. 5
- c. 18
- d. 12

_____ What is the purpose of heating the DNA sample to approximately 95°C in PCR? (1 point)

- a. To separate the DNA strands
- b. To anneal the primers
- c. To elongate the strands
- d. To optimize the temperature for TAQ polymerase

_____ All of the following are added to a PCR tube to perform PCR except _____. (1 point)

- a. Template DNA
- b. Primers
- c. Free nucleotides
- d. Antibodies

_____ Which of the following is not a step in the PCR process? (1 point)

- a. Denaturation
- b. Copying
- c. Annealing
- d. Extension

Part D: Impressions (15% for all of Part D)

Directions: Compare the crime scene impression with the inked impression from the 3 suspects. All of the impressions are shrunk proportionally.

Content Question:

Whose shoe impression matches the crime scene impression? (3 points)

Choose 1 impression you determined was definitely not a match with the crime scene impression and explain why. Feel free to label evidence on the impressions above. (3 points)

Choose 1 individual characteristic in one of the shoes above. Circle and describe why it is an individual characteristic.

Parts E and F: Analysis of the Crime (30%)

Describe what evidence supports and/or refutes the following suspects as being guilty of committing the crime. Use evidence analyzed from parts A-D. Be specific.

SUSPECT 1

SUSPECT 2

SUSPECT 3

Scoring Guide – Forensics – Regional 2017

Part A: Qualitative Analysis (20%)

_____/22 points

_____ % x 0.2 =

Part B: Polymers (20%)

_____/4 points (PLASTICS)

_____/9 points (HAIR)

_____/13 points (FIBER)

_____/26 total points

_____ % x 0.2 =

Part C: Chromatography (15%)

_____/10 points

_____ % x 0.15 =

TOTAL:	_____	/100
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Part D: Crime Scene Physical Evidence (15%)

_____/8 points (DNA)

_____/ 9 points (IMPRESSIONS)

_____/17 total points

_____ % x 0.15 =

Part E: Analysis of Crime Scene (30%)

_____/18 points

_____ % x 0.3 =