

Science Olympiad Division B
Test SSS 2019



Crime Busters
Answer Key



Team Name: _____
Team #: _____
Student #1: _____
Student #2: _____

Do not open this packet until instructed to open it.

This is a 50-minute test. The test may be taken apart but all answers must be recorded on the answer sheet provided. A 10% penalty may apply if a team's work area is not cleaned up as instructed.

The PTA Meeting Gone Wrong

Mr. Doug Giles is a science teacher at a school in upstate New York. Mr. Doug Giles has a prized lab that he always keeps locked. During a PTA meeting, he left both the room and lab unlocked and unattended. One simple mistake quickly turned into grave misfortune.

Mr. Doug Giles was absent from the lab and room for around thirty minutes. During those thirty minutes, someone had gone in and wreaked havoc amongst the clean lab. They had gone in and stolen all the chemicals used, broke equipment (the criminal had cut themselves on the broken equipment), and had left a note. The note left on the lab countertop read “Consider this a warning. You are not in charge of us but the other way around.” Four people have been spotted passing by the lab and room.

Your duty is to: Identify all exhibits/evidence provided and answer the questions in order to help determine who committed the crime.

Information gathered about the Suspects:

Marcus Eden: 5’ 3”; 89 lbs; dark brown hair; blue-grey eyes

- Likes dogs and hates cats
- Wears cotton and silk
- Has a metal iron-plated bottle
- Gets got cheating frequently
- Likes making dessert and favorite dish is jello and fruit

David Bramble: 5’ 5”; 95 lbs; dirty blonde hair; green eyes

- Likes to wear warm wool sweaters
- Likes sculpting
- Brings Aquafina water bottles to school

- Has a pet rat
- Always look stressed and upset in science class
- Hates science class but loves science

Nina McCoy: 5' 4"; 98 lbs; brown hair; hazel brown eyes

- Loves to eat seaweed
- Has a rayon backpack
- In the evenings she takes strolls along the beach and goes to her favorite cafe
- Allergy to cats
- Has a Poland Spring water bottle
- Constantly compared to other students by teachers

Christine Lee: 5' 2"; 91 lbs; black hair; dark brown eyes

- Wears nylon
- Likes KFC chicken and mashed potatoes with gravy
- Has an aluminum plated bottle
- Outcast and disliked by teachers for her quiet demeanor
- Doesn't participate in class due to her shyness

Evidence Recovered

Powder A: from the lab cabinets

Powder B: from the lab counter

Powder C: found on the floor

Powder D: from Marcus' sneakers

Powder E: from Nina's clothing

Powder F: from the kitchen counter

Powder G: found next to the broken equipment

Powder I: found next to the entrance/exit to the lab

Metal A: from the kitchen table

Metal B: on the front lawn

Metal C: on the doorstep

Liquid A: from the area near the lab sink

Liquid B: from lab counter

Liquid C: found on the floor

Hair A: found on edge of the front door

Hair B: found on the floor next to the cabinet of chemicals

Fiber A: found on the broken equipment

Fiber B: found on a chair in the lab

Fiber C: under the doormat in front of the lab's entrance

Plastic A: found by the classroom entrance

Plastic B: found on David's clothes

DNA A: from the crime scene (on the broken equipment)

DNA B: Marcus

DNA C: David

DNA D: Nina

DNA E: Christine

Pen 1: Crime Scene

Pen 2: Marcus

Pen 3: David

Pen 4: Nina

Pen 5: Christine

Part 1: Qualitative Analysis

1. Identify exhibits A through H. Powders H and I could possibly be mixtures. (Every single powder is worth 3 points and mixtures are worth 2 points)

Powder	Identification
A. Turns clear in I ₂ , soluble in water, and no HCl reaction	Vitamin C
B. Soluble but lumpy, stains dark purple in I ₂ and no HCl reaction	Flour
C. Uniform square crystals, soluble in water, no HCl or I ₂ reaction	Salt
D. Soluble with bubbles, turns hard in water, no Hcl reaction, stain yellow in I ₂	Gypsum
E. Soluble and smooth, stains bluish-purple in I ₂ and no HCl reaction	Cornstarch
F. Absorbs water, completely soluble, no I ₂ or HCl reaction, has a	Sodium Acetate

snow-like texture	
G. Insoluble and foggy, stains yellow in I ₂ , and fizzes in HCl	Calcium Carbonate
H. Soluble but fizzes, fizzes in everything but extremely strongly in HCl, also has a few fine crystals but is still a powder	Baking Soda and Alka-Seltzer
I. Uniform square crystals, partly soluble in water, has parts of sediments and no HCl or I ₂ reaction	Sand and Salt

2. What are the three uses of cornstarch? (2 points) **Cooking, stopping/reducing Athlete's foot, and stopping/reducing skin irritation. Other options apply**
3. What is a common use of Powder F in the food flavoring industry? (2 points) **It is used in flavoring salt and vinegar chips.**
4. Limestone, marble, chalk are rocks that primarily consist of? (2 points) **Calcium Carbonate**
5. Which of the allowed powders for this event has the most acidic pH? (2 points) **Vitamin C**
6. What is the chemical formula of Powder D? (1 point) **CaSO₄**

Part 2: Metals

1. Identify exhibits A through C. (All metals are worth 1 point each)

Metal	Identification
A. Gray, density of 2.7 g/cm ³ ,	Aluminum

delayed HCl reaction	
B.Gray, density of 7.31 g/cm ³ , small HCl reaction, yellow tint	Tin
C. Gray, density of 7.13 g/cm ³ , fizzes in HCl	Zinc

2. Which of the allowed metals for this event is paramagnetic? (1.5 points) **Tin**
3. Which metal violently fizzes in HCl? (0.5 point) **Magnesium**
4. Which metal, when in contact with hydrogen sulfide, can give off a rotten egg smell? (1 point) **Iron**

Part 3: Liquids

1. Identify exhibits A through C. (All liquids are worth 1 point each)

Liquid	Identification
A. No smell, ph of 7, no reaction in anything	Water
B. Sharp smell, ph of 11, no reaction in anything, cloudy	Ammonia
C.No smell, ph of 7, bubbles in I2, density of 1.45 g/mL	Hydrogen Peroxide

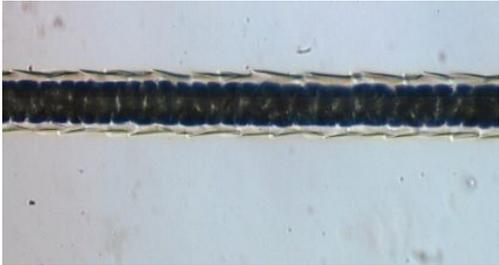
2. Which allowed liquids for this event has neither an acidic or basic pH? (2 points)

Water, Rubbing Alcohol, and Hydrogen Peroxide

3. Which two allowed liquids for this event may be used to clean cuts? (2 points) **Rubbing Alcohol and Hydrogen Peroxide**
4. What is the chemical formula for Liquid B? (2 points) **NH₃**

Part 4: Hair

1. Identify exhibits A and B. (All hairs are worth 1 point each).

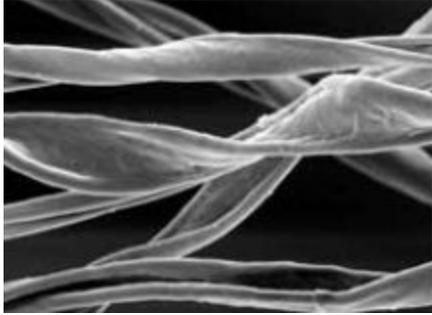
Hair	Identification
<p>A.</p> 	<p>Cat</p>
 <p>B.</p>	<p>Human</p>

2. What is the medullary index of cat hair? (1 point) **<0.5**
3. How do you distinguish between cat and dog hair? Please provide two reasons. (2 points) **Cat is finer than dog hair. Cat hair also has a smaller medulla. In addition, dog hair has an outer coat that is generally very coarse and often straight and the undercoat is often fine and can be very curly. Other answers are also acceptable.**

Part 5: Fibers

1. Identify exhibits A through C.

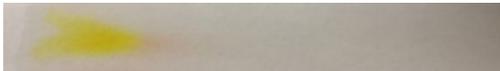
Fiber	Identification
-------	----------------

 <p>A. (1 point)</p>	<p>Vegetable (Cotton)</p>
<p>It burns without flame or melting and may flare-up. Doesn't leave any bead. It smells like burning paper and leaves soft, gray ash. What type of fiber is this? (2 points)</p>	<p>Synthetic (Rayon)</p>
<p>It is a protein fiber that burns slowly. It sizzles and curls away from the flame. It leaves beads that are brittle, dark, and easily crushed. It is self-extinguishing and leaves harsh ash from the crushed bead. It smells like burning hair. What type of fiber is this? (2 points)</p>	<p>Animal (Wool)</p>

Part 6: Chromatography



1. Which chromatography matches the one above? (1 point) **Nina**

	<p>Marcus</p>
	<p>David</p>

	Nina
	Christine

2. What is the mobile phase and the stationary phase in paper chromatography? (1 point) **The solute going up the stationary phase is the mobile phase and the paper is the stationary phase.**
3. Calculate the Rf of each chromatogram. These are not the chromatograms above. These are just additional questions to test your knowledge of Rf. D1 is the distance the solute traveled and D2 is the distance traveled by the solvent(3 points)

- 1)A chromatogram has a D1 of 5 cm and a D2 of 15 cm: **0.33333... or 1/3**
- 2) A chromatogram has a D1 of 7 cm and a D2 of 20 cm: **0.35 or 7/20**
- 3) A chromatogram has a D1 of 2.5 cm and a D2 of 10 cm: **0.25 or 1/4**

Part 7: DNA Analysis

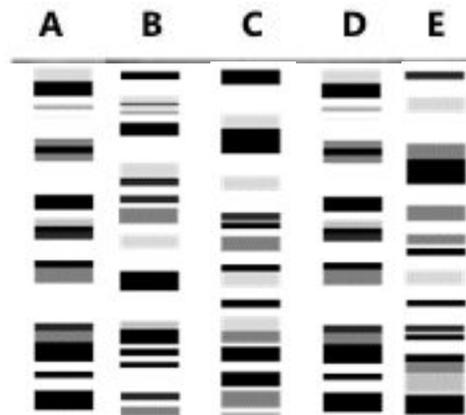
The following DNA was contained from suspects at the scene. The wells are labeled with letters according to the evidence list.

1. Identify any matches in the DNA to the right. (3 points) **Crime Scene DNA matches that of Nina's**

2. What is the name of the DNA method is shown to the right? (2 points) **Gel electrophoresis**

Part 8: Fingerprints

Fingerprints of each suspect were collected and are provided in the chart below.



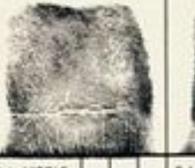
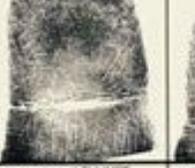
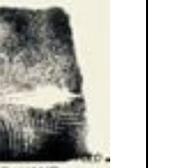
Right Hand

				
Thumb	Index Finger	Middle Finger	Ring Finger	Pinky Finger

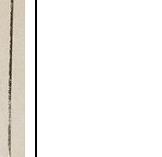
Left Hand

				
Pinky Finger	Ring Finger	Middle Finger	Index Finger	Thumb

Marcus

1. R. THUMB	2. R. FORE	3. R. MIDDLE	4. R. RING	5. R. LITTLE
				
• FOLD				FOLD
6. L. THUMB	7. L. FORE	8. L. MIDDLE	9. L. RING	10. L. LITTLE
				
• FOLD				FOLD
Plain impression of the 4 fingers L. HAND		Plain impression of THUMB seen SMALL FINGERS		Plain impression of the 4 fingers R. HAND

David

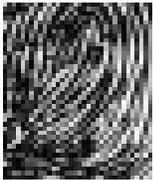
<p style="writing-mode: vertical-rl; transform: rotate(180deg);">POLICIA DE LA PROVINCIA DE BUENOS AIRES</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Seccion de Identificacion</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">N°</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">DERECHA</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">IZQUIERDA</p>					
	PULGARES	INDICES	MEDIOS	ANULARES	MEÑIQUES
					

Nina

RIGHT HAND				
1. Thumb	2. Index finger	3. Middle finger	4. Ring finger	5. Little finger
				
LEFT HAND				
6. Thumb	7. Index finger	8. Middle finger	9. Ring finger	10. Little finger
				

Christine

1. Who does fingerprint Q1 belong to?
(shown to the right) (2 points) **Marcus**



Q1

2. Who does fingerprint Q2 belong to?
(shown to the right) (2 points) **Nina**



Q2

3. What type of fingerprint is Q2? (1 point) **Arch**

Part 9: Footprints

Footprints of each suspect were collected and are provided in the chart below.

	Marcus
	David

	Nina
	Christine

Who does footprint Q1 belong to?
(shown to the right) (5 points)

Nina



Q1

Part 10: Analysis (25 points)

1. Based on the evidence analyzed, who is the prime suspect and why? Refer to specific evidence such as powders, metals, DNA, footprints, and etc. (12 points max, 3 points for properly identifying who did it, 5 points for their motive or the why part of the question, and 4 points for referring to at least 3 specific pieces of evidence)
2. What evidence did you find that didn't implicate anyone? Explain why it didn't implicate anyone. (8 points max, 4 points for stating at least 3 specific pieces of evidence and 4 points for explaining.)
3. What other evidence could have been provided that would have been helpful to solve this crime? Provide reasoning for your answer. Explain how this would have been used in your final analysis and deduction. (5 points max, 2 points for stating other evidence that could have been useful, 2 points for providing reasoning, and 1 point for

explaining how the evidence would have been incorporated into the final analysis)

Other answers are valid but this is a sample answer and outline of a 25 point answer.

1. Based on the evidence provided it can be deduced that Nina has committed the crime. For example Mixture I implicates Nina since she may have small traces of sand and salt on her from the beach and from eating seaweed. In addition, Powders B, C, and E also implicate Nina since Nina may have picked up some flour or cornstarch from the cafe and salt from the food she ate. Furthermore, fingerprint Q2, the footprint, chromatography, and the DNA found at the crime scene all match the evidence gathered from Nina. Liquid A implicates Nina since she goes to the beach and carries a water bottle with her. However, Liquid A can also implicate all of the other suspects since they also bring water bottles. Nina is also probably the culprit since constantly being compared to other students may make her upset and uncomfortable. She may be seeking revenge on the teachers that compare her and Mr. Doug Giles may have been one of these teachers.

2. Metals B and C, Liquids B and C, and Hair A do not implicate anyone. None of the suspects seem to have any object that is listed containing either tin or zinc. Liquids B and C are commonly found in labs and have nothing to do with any of the suspects' hobbies or descriptions. The two liquids were probably accidentally spilled when the criminal was trying to steal them. Finally, Hair A has nothing to do with the suspects since no one has a cat and some suspects dislike or have allergies to cats.

3. Polymers or plastics would be useful since it could implicate suspects that carry plastic bottles to school. In addition, witness reports would be useful since they would provide height and appearance descriptions. However, witness reports may be inaccurate since many witnesses' memories are faulty and unreliable due to forgetfulness. These would be used to make a more accurate final conclusion and would be included as extra evidence to back up my final claim.

Further and Example Scoring:

Powder B (1 point), Mixture I (1 point), and Powder C (1 point) were found on Nina. The DNA (1 point) of Nina also matches that of the crime scene. Liquid A from the crime scene is found on all suspects, so it doesn't necessarily implicate anyone (2 points).