Battle at Valley Forge Invitational 2017

— Forensics —

School: ________________________________

Team Number: ______

Competitor Names: ________________________________
BACKGROUND INFORMATION

After a long year balancing fighting crime with their normal lives, the Incredibles decided to treat themselves to a family vacation to the Bahamas over winter break. They flew to the island on Frozone’s private jet and cabbed to the Atlantis Star Hotel to drop off their luggage in the hotel room. Before it was even noon, they were changed and ready to get their vacation started. Assigned a tour guide by the hotel, they leave for a day of sun, beach, and unparalleled luxury. However, when they arrive back at their room in the evening, they find their hotel room in an absolute mess with drawers pulled open and linens strewn on the floor. All of the money they had withdrawn before arriving is gone and their hero eye-masks ripped apart.

On the wall, in paint still drying, a message reads: “HOW SUPER DO YOU FEEL NOW?”

While an ordinary family would have gone straight to the authorities, the Incredibles remained cool and collected. Dash scampered around the room, taking note of every piece of evidence, while Helen stretched herself to her limits to inspect every nook and cranny. Rob gave them a hand by lifting up the heavy furniture. Using her superpower to generate force fields, Violet carefully inspected unusual hairs, fibers, stains, and other physical remnants without leaving a single fingerprint. Jack-Jack stood—well, sat—guard at the door, making sure his family worked undisturbed.

They compiled a list of all of their findings:

- Powder Sample 1 (near the entrance)
- Powder Sample 2 (on the bathroom floor)
- Powder Sample 3 (next to the painted wall)
- Plastic Sample
- Fiber Sample 1
- Fiber Sample 2
- Blood Sample
- Note written in pen that reads: “Enjoy your stay, hope it is superb. Glad superheroes carry ca$$h”
- A paintbrush with only loop fingerprints
- An solid piece of unidentified, transparent material
- The height and dimensions of a distinct paint spatter
- Traces of a loamy soil on the floor that doesn’t match any of the soils found at the bottom of the Incredibles’ shoes

Other notes:

- Female and male workers are issued different sets of uniforms. Women are given uniforms made from cotton while men’s uniforms are made from nylon.
- Aside from the missing cash and destroyed eye-masks, nothing else is missing
SUSPECT 1

Name: Joseph Jackson
Nickname(s): Joe, JJ
DOB: March 12, 1994
Age: 22
Occupation: Housekeeper

Sex: Male
Hair color: Blond
Height: 5’10”
Blood Type: AB+
Eye color: Green

Background: Joseph, or Joe, Jackson was born on the island to a low-income family and is the middle of 7 children. He has been employed at the hotel since he was 14 years old, and has gone from a shoe-shiner and pet-sitter to one of the hotel’s most loyal housekeepers. Joe still lives with his family and helps support them with his earnings. He enjoys surfing and playing tennis with his fellow employees, in which he has an advantage as a lefty.

Alibi: “Man, I knew everyone would be pointing fingers at me! I’m just a poor ole housekeeper! I’ve been working here since my early teens, why would I jeopardize my only source of income by robbing these guests? Especially since they be superheroes! I admit that I was in their room sometime earlier in the morning, but just to do my normal cleaning rounds and to ready their room for their arrival. Haven’t been in there since then, been too busy cleaning and doing laundry!”

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SUSPECT 2

Name: Mason Montclair
Nickname(s): M&M, Mace
DOB: June 3, 1989
Age: 27
Occupation: Lifeguard, Gardener

Sex: Male
Hair color: Black
Height: 6’2”
Blood Type: O+
Eye color: Blue

Background: One of the hotel’s newest employees, Mason, or (as the staff is starting to call him) M&M, was born in the U.S. and came to the island after his plane crashed in the middle of the ocean. He wears a Plexiglass necklace with a shard of the plane’s window as a result. Since he’s been here, Mason has been hopping from job to job, never staying at one establishment for long. The hotel manager, desperate to replace the former lifeguard who left at the start of peak season, offered Mason the job without going through the complete acceptance process.

Alibi: “Duuuuude, chillllll. I was just down at the pool doing my job lifeguarding. You got no trouble from me, broski. I’m a good guy who saves lives. I just look over the guests, clean the pool, occasionally do some gardening to keep that flora and fauna ’round the pool looking fresh. We all good brah, we all good.”

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SUSPECT 3

Name: Liza Lafar
Nickname(s): Liz, Li-La
DOB: January 25, 1993
Age: 23
Occupation: Concierge

Sex: Female
Hair color: Black
Height: 5’2”
Blood Type: A-
Eye color: Black

Background: Liza, or Liz as most of the staff call her, was orphaned at a young age and grew up in foster care. She graduated from the local university a year ago and has been working for the hotel since then, scheduling tours and planning many of the guests’ entire vacations. An intelligent and diligent worker, she has received high satisfaction ratings from customers. Liz lives in a small shack owned by the hotel. To make some extra spending cash (and to make use of the bugs in her infested shack), she makes amber pendants to sell to tourists. She is right-handed and also part of the island’s anti-superpower league. She is a firm believer of relying on one’s perseverance and indomitable spirit for success.

Alibi: “I’ve been booking tours and scheduling the ideal vacation for guests all day! It’s peak season you know. I don’t have time for this hooliganry. These supers can take care of themselves—I mean, they’re called “super” for a reason, right?”

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SUSPECT 4

Name: Janice Jahn
Nickname(s): Jan, Ja-Ja
DOB: November 16, 1995
Age: 21
Occupation: Towel-folder

Sex: Female
Hair color: Medium Brown
Height: 5’5”
Blood Type: B+
Eye color: Green

Background: Janice, or Ja-Ja, was born in Athens, Georgia. A precocious youth, she studied at MIT for a year before dropping out to pursue her passion of towel-folding. Since coming to the island, she has been in hot demand by hotels and resorts. The hotel manager was only able to lure her to the establishment by offering her a startling high salary and unlimited use of the hotel sauna. In addition to towel-folding, Ja-Ja is very artistically inclined, is right-handed, and loves music and the arts. She enjoys helping Liz make pendants after work.

Alibi: “Howdy y’all! You say there’s been a crime around here? Man, you don’t hear about a single thing while folding these adorable towel animals in the back room. You know those oh-so Instagram-able towel animals people get on cruises and at resorts? My job is to fold them! Aren’t they just adorable? Now if only they could talk, they’d tell you that all I’ve been up to is good!

Left: Thumb (top), Index (bottom) Right: Thumb (top), Index (bottom)
SUSPECT 5

Name: Morgan Mabel
Nickname(s): ‘Mo, MoMa
DOB: April 2, 1954
Age: 62
Occupation: Tour Guide

Sex: Male
Hair color: Gray
Height: 5’8”
Blood Type: O+
Eye color: Black

Background: Born and raised on the island, ‘Mo is one of the hotel’s oldest employees, both in age and in years worked. He knows the local area like the back of his hand and routinely gives tours to families staying at the hotel. ‘Mo is well-loved by the rest of the staff and lives in a small house near the hotel with his wife of 35 years and two dogs. His two children live in the United States. In his spare time, ‘Mo enjoys whittling and has trained himself to be left-handed since his right hand has grown stiff as of late.

Alibi: “Now, now, the fact that you’re suspecting me is interesting because I’ve spent the whole afternoon with your family! Lovely people, you are, though the kids—especially the two younger ones—can be a tad rowdy. Nevertheless, I’m too old for these shenanigans; who in his right mind would try to pull off a robbery with a hands as jittery and stiff as mine? Plus, I make enough money off you rich people’s tips already to live a comfortable life.

Left: Thumb (top), Index (bottom) Right: Thumb (top), Index (bottom)
Part A: Qualitative Analysis

Determine the identity of each of the eight powders provided. On the answer sheet, write both the SCIENTIFIC NAME and CHEMICAL FORMULA for each sample.

- Sample 1 (Crime Scene)
- Sample 2 (Crime Scene)
- Sample 3 (Crime Scene)
- Sample 4 (Suspect 1)
- Sample 5 (Suspect 2)
- Sample 6 (Suspect 3)
- Sample 7 (Suspect 4)
- Sample 8 (Suspect 5)

1. Which suspect(s) do(es) the evidence implicate?

Part B: Plastics

1. The hotel issues each employee a bracelet made completely from a certain type of plastic. The suspects are numbered so that their numbers correspond to the resin number of their bracelets’ material. The piece of plastic found at the crime scene most likely came from a hotel-issued bracelets. The Incredibles quickly perform a density test using mixtures of solutions they had on hand. The densities of the solutions (in g/cm³) are: 1.00 (water), 1.37 (corn syrup), 0.90 (ethyl acetate), 0.79 (acetone). Calculate the densities of the underlined aqueous solutions and identify the material based on the following information:

Water: floats
29% acetone solution: sinks
20% ethyl acetate solution: floats
52% corn syrup solution: floats

Part C: Fibers

Determine what material each fiber is made from. On the answer sheet, write both the NAME of the material and whether it is SYNTHETIC or NATURAL.

- Sample 1 (Crime Scene)
- Sample 2 (Crime Scene)
- Sample 3
- Sample 4
- Sample 5

1. Which suspect(s) do(es) the evidence implicate?

Part D: Hairs

1. Answer the following questions regarding each hair sample:
   Sample 1
   a. What is the medulla pattern present?
   b. What is the cuticle pattern?
   c. What is the animal of origin?
   Sample 2
   a. What is the medulla pattern present?
   b. What is the animal of origin?
   Sample 3
   a. What is the medulla pattern?
Sample 4
a. What is the medulla pattern present?
b. What is the cuticle pattern?
c. What is the animal of origin?

2. How can you discern human hair from animal hair?
3. ______________ are large, solid structures that can be spherical or oval in shape. They are abundant in the hairs of ______________ (there can be one or multiple answers, choose from: humans, dogs, cats, squirrels, cows)

Part E: Chromatography/Spectroscopy
1. Calculate the Rf values for the crime scene sample (isolated from the note) and samples (see pg 5) obtained from the suspects. Which suspect(s) do(es) this evidence implicate? Attach your developed chromatograph to the answer sheet.
2. If there are two spots on a paper chromatograph developed with ethanol, the spot that has traveled further contains a compound that is more/less (circle one) polar than the compound found at the lower spot.
3. In the given chromatography set-up, what is the mobile phase? The stationary phase?

Part F: Fingerprint Analysis
1. Identify each type of fingerprint (be as specific as possible). Assuming that each person writes using his/her dominant hand, which suspect(s) do(es) the evidence implicate?
2. ______________ prints have to be developed before they can be visible to the naked eye.
3. ______________ reacts with amino acids and proteins on fingerprints. The ridge details are stained a ______________ color.
4. ______________ reacts with fats and oils to visualize ridge details.
5. ______________ reacts with chlorides and salt components and is developed using ______________.
6. The most common fingerprint pattern is the ______________ which account for ____% of all prints. The least common pattern is the ______________ which account for ____% of all prints.

Part G: DNA
1. After DNA is isolated from its biological course material, specific regions are copied using PCR. What are these regions called?
2. Should PCR be used when there is a highly degraded and impure DNA sample? Explain your answer.
3. Which of the following can be sources of DNA?  
   Hair clippings, Sweat, Blood, Nails, Dandruff, Ear Wax
4. List the steps of PCR.
5. If you start with 2 pieces of DNA and each cycle takes approximately 5 minutes, how many pieces of DNA will you have after an hour?
6. The polymerase attaches free ______________ end of the DNA sample. Because of the high temperatures in PCR, ______ polymerase is used.

Part H: Glass Analysis

The refraction index of the material found at the crime scene is 1.48. Determine the refraction index for each of the materials (see pg. 9). Please show all of your work and calculations to receive full credit.
1. What is the crime scene material? Which suspect(s) do(es) this evidence implicate?
Part I: Entomology
1. Why are flesh flies attracted to dead bodies?
2. Give the family and common name of the first type of insect to arrive at a dead body.
3. If blowflies are found on a corpse in a closet, what can you infer about the corpse?
4. Necrophagous species, like beetles and houseflies, are called necrophagous because ________________________.
5. True flies undergo ______________ metamorphosis, meaning they have ________________________ stages (list the stages).

Part J: Blood Analysis and Spatters
1a. Besides the painted letters, it also looks like paint has been flung onto the wall. One of the spatters is 2.1 inches wide and 4.8 inches long. Assuming that the person who created the spatter is standing a yard from the wall and flicks the paintbrush with his/her hand fully extended above his/her head, how tall is the person? (A person can reach about a quarter of his/her height).

1b. If the person was taller, the size of the spatter would be ______________.
2. Describe the blood stains resulting from each of the following. Be sure to talk about the pattern and size of the spatters in your descriptions.
   a. Knife stab
   b. Whack from a bat or hammer
   c. Gunshot
3. What are the four phases of impact for a blood spatter?
4. When a person or object blocks the path of the blood, a ______________ pattern occurs.
5. Name the labeled components of the spatter:

6. Determine the ABO type of the blood found at the crime scene. Which suspect(s) do(es) this evidence implicate?

Part K: Bullet Striations
1. What does it mean when a gun barrel is rifled? What is the effect of rifling?
2. What is a safe conclusion to make when gunpowder residue is found on the victim that is shot?
3. Firing pins leave impressions on the __________ of each bullet fired.
4. Label the bullet below and describe its twist.
5. What is the caliber of a bullet?
6. What is the diameter of a bullet if there are 8 lands and grooves (each) and the land impression has a width of .055 inches and the groove impression has a width of .84 inches?
7. What is the pitch of a barrel?
# ANSWER SHEET

School Name: ____________________________ Team Number: __________

**PLEASE PUT ALL OF YOUR ANSWERS ON THE ANSWER SHEETS. ANSWERS WRITTEN ON TEST SHEETS WILL NOT BE GRADED**

## Part A: Qualitative Analysis

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Scientific Name</th>
<th>Chemical Formula</th>
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<tbody>
<tr>
<td>1</td>
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<td>8</td>
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</tbody>
</table>

1. ________________________________________________________________

## Part B: Plastics

1. *Show all calculations to receive full credit.*

Density of 29% acetone solution: ____________________________

Density of 20% ethyl acetate solution: ____________________________

Density of 52% corn syrup solution: ____________________________

Evidence implicates: ____________________________________________
Part C: FiberS

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Material</th>
<th>Synthetic or Natural</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Crime Scene)</td>
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<tr>
<td>2 (Crime Scene)</td>
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<td>5</td>
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</tbody>
</table>

1. ____________________________________________

Part D: Hairs

1. Sample 1:  a. ______________________  b. ______________________  c. ______________________
   Sample 2:  a. ______________________
   Sample 3:  a. ______________________  b. ______________________  c. ______________________
   Sample 4:  a. ______________________  b. ______________________  c. ______________________

2. ____________________________________________

3. ____________________________________________

Part E: Chromatography/Spectroscopy

<table>
<thead>
<tr>
<th>Sample</th>
<th>Calculations (Show ALL calculations to receive full credit)</th>
<th>Rf value(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspect 1 (1)</td>
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<tr>
<td>Suspect 2 (2)</td>
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<td>Suspect 3 (3)</td>
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<td>Suspect 4 (4)</td>
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<tr>
<td>Suspect 5 (5)</td>
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<tr>
<td>Crime Scene</td>
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</tbody>
</table>

1. ________________________________

Tape or staple developed chromatograph here
2. __________________________

3. Mobile Phase: __________________________  Stationary Phase: __________________________

Part F: Fingerprint Analysis

<table>
<thead>
<tr>
<th>Suspect 1</th>
<th>Suspect 2</th>
<th>Suspect 3</th>
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<table>
<thead>
<tr>
<th>Suspect 4</th>
<th>Suspect 5</th>
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1. __________________________

   __________________________

   __________________________

   __________________________

   __________________________

Part G: DNA

1. __________________________

2. __________________________

   __________________________

   __________________________

3. __________________________
4. ______________________________________________________________________________

5. 

_________________________ pieces of DNA

6. _________________________, ________________________

Part H: Glass Analysis

PMMA: ________________________

Diamond: ________________________

Amber: _________________________

1. ______________________________________________________________________________

Part I: Entomology

1. ______________________________________________________________________________

2. _________________________, ________________________

3. ______________________________________________________________________________

4. ______________________________________________________________________________

5. _________________________, ________________________

Part J: Blood Analysis and Spatters

1. Show all work.

a) ________________________
b) __________________

2. a) __________________

b) __________________

c) __________________

3. __________________, __________________, __________________, __________________

4. __________________

5. a) __________________

b) __________________

6. __________________

Part K: Bullet Striations and Gunshot Residue

1. __________________

2. __________________

3. __________________

4. a) __________________

b) __________________

Twist: __________________

5. __________________

6. __________________

7. __________________
CRIME SCENE ANALYSIS

Fill out the table below and write your conclusion about the crime.

<table>
<thead>
<tr>
<th>Suspect</th>
<th>Evidence</th>
<th>Verdict</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspect 1 (Joe Jackson)</td>
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<td></td>
</tr>
<tr>
<td>Suspect 2 (Mason Montclair)</td>
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<tr>
<td>Suspect 3 (Liza Lafar)</td>
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<tr>
<td>Suspect 4 (Janice Jahn)</td>
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<td></td>
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<tr>
<td>Suspect 5 (Morgan Mabel)</td>
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Explanations/Rationale:

__________________________________________________________________________
__________________________________________________________________________
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