



Exploring the World of Science

Inaugural University of Michigan
Science Olympiad Invitational Tournament

[FORENSICS]
(EXAM)

Test length: 50 Minutes

Team number: _____

School name: _____

Student names: _____

Forensics C

University of Michigan Invitational

February 17, 2018

Names:

Team Name:

Team Number:

For Scoring Use	
A	
B	
C	
D	
E	
Total	

Reminders

1. You may take the test apart, but please reassemble it – in order – at the end.
2. Keep your safety goggles on at all times. If you need to defog them, step away and/or turn away from any nearby hazards first.
3. Please tidy up your station after you are done. Failing to do so will incur a 10% penalty.
4. The first tiebreaker is the subscore for Section E (Crime Scene Analysis). Subsequent tiebreakers will be the subscores for Sections A (Qualitative Analysis), D (Physical Evidence), B (Polymers), and C (Chromatography), in that order.
5. Time is not a tiebreaker!

Following the competition, this test will be posted publicly on the scioly.org Test Exchange (https://scioly.org/wiki/index.php/2018_Test_Exchange). If it has not been posted within 2 weeks, I've probably just forgotten – you can remind me at linandr@umich.edu.

Case Notes

This is not the Forensics test.

In fact, someone stole the Forensics test last night.

It was a cold, snowy February night, and the University of Michigan campus was quiet. Tests had been printed, scoresheets had been organized, notesheets had been made, builds had been finished, and there were *definitely not* any last-minute preparations or studying going on. In short, everything was ready for the invitational.

But when Andrea, the Forensics event supervisor, arrived (very) early this morning to set up the lab, she found the door had been forced open, the lab was completely trashed, and her test was missing!

Now it's up to you to figure out the culprit and save the tournament...

Suspect Profiles

Ben, the Science Olympian from East HS

Ben is a senior at East HS. He has a rivalry with Margaret – they first met at a Science Olympiad competition in middle school, and immediately decided they didn't like each other.

He has been devoting a lot of time to building his team's Mission Possible, a curious contraption of plywood, PVC, and duct tape. Unfortunately, it's a bit temperamental, and Ben has a cut on his face from a testing mishap yesterday where it may have *slightly* exploded. However, he was prepared for this situation, and carries around a medical kit with bandages and supplies to treat minor burns, including reusable cold packs.

Ben is wearing a crisply starched linen shirt and khakis, along with a thick winter coat, since he spent the time between his events outside feeding the squirrels on the Diag.

He suspects that Margaret stole the test so that she could win first place in Forensics.

Margaret, the Science Olympian from West HS

Margaret is also a senior, and captain of the West HS Science Olympiad team. Between managing the team and studying for her own events (particularly so that she can do better than Ben), she is very busy. In the little bit of free time that she does have, she enjoys tending to her collection of potted plants, which she has to continuously set upright again after her cat has tipped them over.

Margaret is wearing a hoodie with her school's mascot, athletic pants, and a winter coat. She also wears contacts, and keeps a spare set in her purse, along with several pencils and a small makeup kit. In addition, her right foot is in a cast – she went out for a run a few weeks ago, slipped on ice, and broke her ankle. She also has some cuts on her other leg, due to her cat.

She suspects that Ben stole the test so that he could win first place in Forensics.

Andrea, the Event Supervisor

Andrea is the event supervisor for Forensics, and is currently having a bit of a nervous breakdown because everything is going wrong today, starting when she cut her hand on broken glass while investigating the lab this morning.

When she is not busy freaking out, Andrea enjoys playing the violin and also baking. Yesterday, when things were not (metaphorically) on fire, she had gone to the grocery store for ingredients to try out a new recipe for blueberry muffins.

She is wearing a t-shirt, jeans, and a lab coat along with chemical splash goggles over her glasses.

She suspects that Adam stole the test so that he could eliminate his competition for “Best-Run Event” at the invitational.

Adam, the Lead Testwriter

Adam is the lead testwriter, in charge of managing all the test events at the invitational, though the event he directly supervises is Astronomy. He is also involved in a lot of science outreach activities, and one of his latest experimental demos contains brightly colored fire, and the other involves constructing... something... out of plastic jugs. (It’s still very much a work in progress.) Adam has also spent the past week trying to shoo some bats out of the observatory.

He is wearing a collared shirt and slacks, along with a tweed jacket and a fancy tie – all of which are covered in chalk dust – and his left hand is bandaged because he cut himself with a kitchen knife while cooking dinner. He also wears glasses.

He suspects that Liz stole the test as revenge for being chronically underappreciated by Andrea.

Liz, the Assistant Supervisor

Liz is the assistant supervisor for Forensics. She got dragged into this whole mess by Andrea, because she had lots of experience in a chemical engineering lab, and that’s close enough, right?

One of her hobbies is art. She owns a set of fine paintbrushes for watercolor, and has also started learning how to make and decorate pottery – though she accidentally dropped her last ceramic piece, and one of the shards sliced her leg.

Liz is perpetually cold, and is wearing a thick wool sweater, jeans, and a wool scarf. (She also has some hand warmers and a Mylar blanket, just in case.)

She suspects that Andrea “stole” her own test so that she could write this annoyingly meta scenario.

Evidence List

LABEL	EVIDENCE TYPE	LOCATION/PERSON
A	Powder	Ben
B	Powder	Margaret
C	Powder	Andrea
D	Powder	Adam
E	Powder	Liz
F	Powder	Traces in hallway outside lab door
G	Powder	Just inside lab entrance
H	Powder	Spilling out of overturned container in lab
I	Plastic	Fragments on lab floor
J	Plastic	Fragments on lab floor
K	Plastic	Scattered around lab area
L	Fiber	Threads found on lab table
M	Fiber	Shreds found among broken lab glassware
N	Fiber	Scrap found just inside lab entrance
O	Hair	Next to overturned container
P	Hair	Lab door handle
Q	Mysterious Note	Underneath a lab table
R	Mass Spectrum	Unknown substance on floor
S	Mass Spectrum	Unknown substance covering lab counter
T	Blood Spatters	Lab floor
U	Broken Glass Shards	Lab floor
V	Fingerprints	On Mysterious Note
W	Fingerprints	On (non-broken) glassware

Section A: Qualitative Analysis

[24% Total]

The chemical name, the chemical formula, or the common name of the compound are all acceptable.

A. [3] _____

B. [3] _____

C. [3] _____

D. [3] _____

E. [3] _____

F. [3] _____

G. [3] _____

H. [3] _____

Section B: Polymers (Plastics, Fibers, & Hairs)

[16% Total]

For plastics, either the abbreviation or the full name is acceptable (but the recycling code is not).

Plastics

I. [2] _____

J. [2] _____

K. [2] _____

Fibers

L. [2] _____

M. [2] _____

N. [2] _____

Hairs

O. [2] _____

P. [2] _____

Section C: Chromatography and Spectroscopy

[12% Total]

A mysterious note written in black ink (Evidence Q) was found in the lab, reading as follows:

Bmm bddpsejoh up nz fwjm qmbo...

The Rfs of the pigments in the ink – blue and red – were 0.25 and 0.55, respectively.

Of the five suspects, only Margaret and Andrea had black markers. The chromatograms for these markers are shown on the accompanying evidence sheet.

Calculate Rfs for the blue and red pigments in each marker.

[2] Margaret: _____

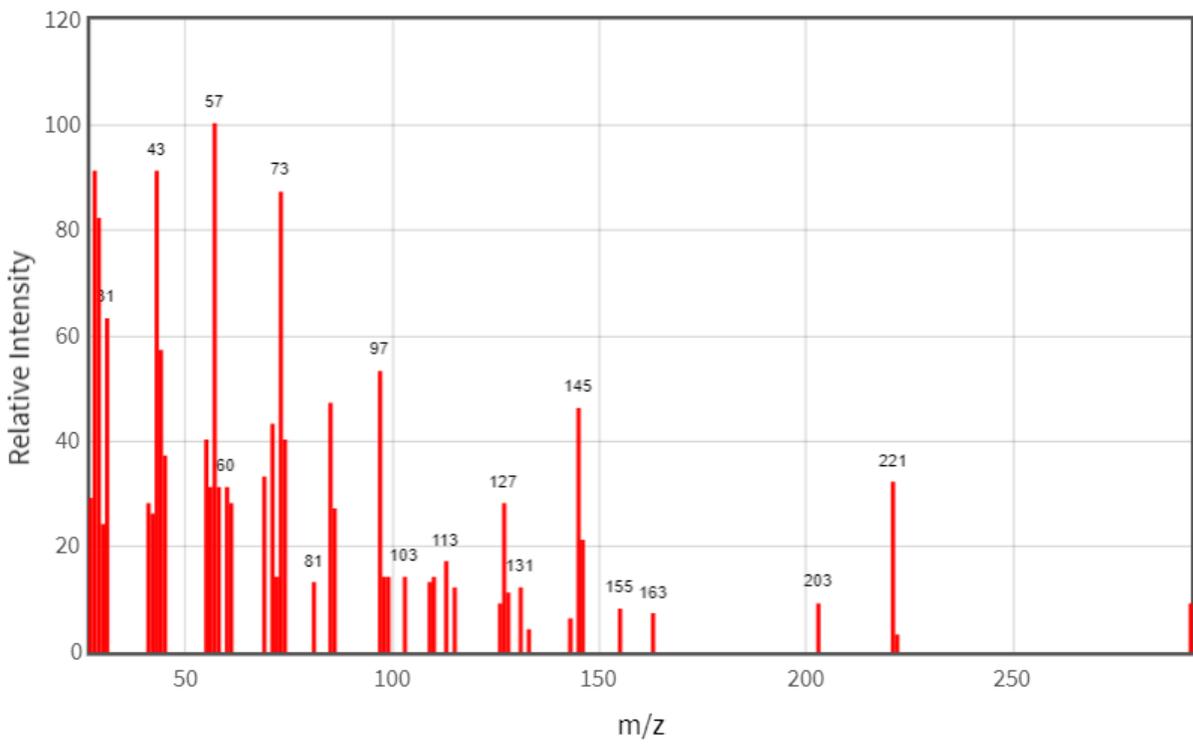
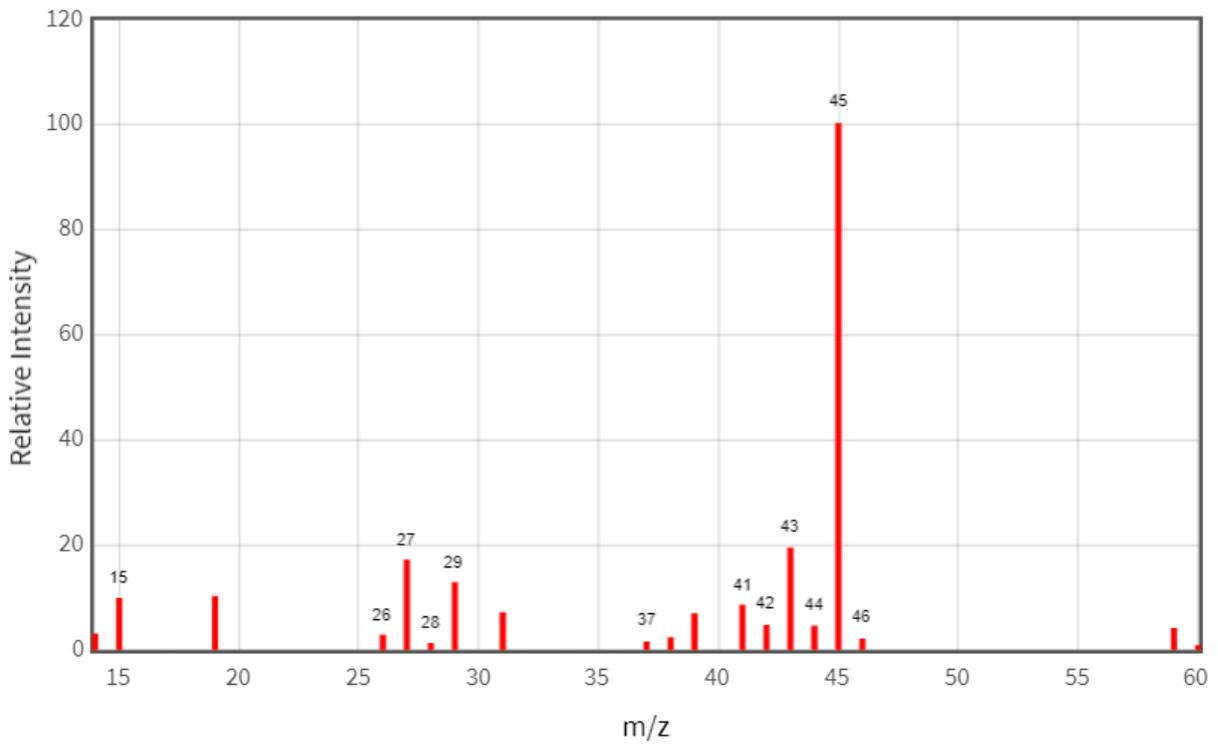
[2] Andrea: _____

[2] What condition must be satisfied in order for Rf comparisons to be valid? (In the crime scene analysis section, you can assume that this condition is in fact true.)

What compounds are depicted in the mass spectra on the next page?

[3] Top: _____

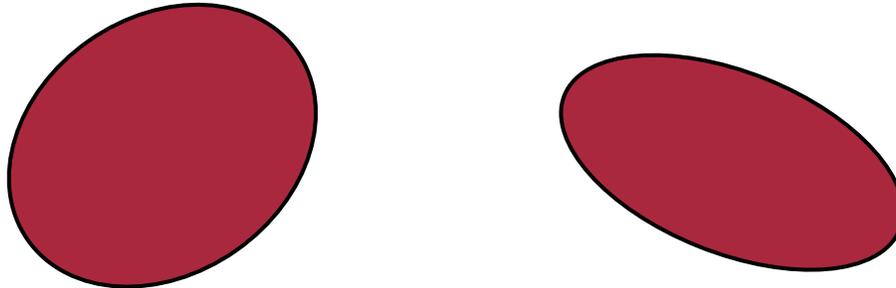
[3] Bottom: _____



Section D: Crime Scene Physical Evidence

[18% Total]

Blood droplets were discovered on the floor of the lab. Two of them are reproduced below, magnified. The one on the left was 1.7 m from the point of intersection, and the one on the right was 3.3 m.



If both droplets originated directly above the point of intersection, what were their starting heights?

[2] Left: _____

[2] Right: _____

A small pile of broken glass was also discovered on the floor of the lab. It was found that light shined into a sample of the glass at an angle of 70.0° propagated through it at an angle of 39.6° .

[2] What is the index of refraction? _____

[1] What type of glass is this? _____

A few fingerprints were also recovered from the crime scene. The one on the left is Evidence V, and the one on the right is Evidence W.

(Questions follow on next page.)



[2] What is the classification of the fingerprint on the left (be specific)?

[2] What is the classification of the fingerprint on the right (be specific)?

[2] Do these fingerprints match any of the suspects, and if so, who?

[1] If the fingerprints on Andrea's other (left) hand are all whorls, what is the Henry classification?

[1] Explain how silver nitrate reacts to reveal fingerprints.

[1] What biological difference leads to different types of fingerprints?

Section E: Crime Scene Analysis

[30% Total]

For each suspect, decide whether they should be released or held for further questioning. Remember to justify your decisions with evidence, and explain why each relevant piece of evidence points to the guilt/innocence of that suspect.

SUSPECT: BEN	Hold for Questioning?

SUSPECT: MARGARET	Hold for Questioning?

SUSPECT: ANDREA

Hold for Questioning?

SUSPECT: ADAM

Hold for Questioning?

SUSPECT: LIZ

Hold for Questioning?

BONUS [1 pt]: What does the Mysterious Note say?
