

Forensics C – KEY

University of Michigan Invitational

February 17, 2018

For Scoring Use	
A	24
B	16
C	12
D	18
E	30
Total	100

Notes

So... I can't add, and didn't realize that Section D is actually 16 points instead of 18.

When it was scored, everyone received 2 extra points (we made sure this was consistent).

Section E is scored as follows:

~ 6 points per suspect (times 5 suspects)

~ 1 point each for up to 4 pieces of evidence

~ 2 points for a yes/no based on the evidence

Tiebreakers (in order) are the subsection scores for Sections E, A, D, B, and finally C.

Mean Score, $\bar{x} = 36.5$

Standard Deviation, $\sigma = 14.5$

Section A: Qualitative Analysis

[24% Total]

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

A. [3] Sodium bicarbonate (NaHCO_3)

B. [3] Calcium sulfate (CaSO_4)

C. [3] Lithium chloride (LiCl)

D. [3] Ammonium chloride (NH_4Cl)

E. [3] Glucose ($\text{C}_6\text{H}_{12}\text{O}_6$)

F. [3] Calcium nitrate ($\text{Ca}(\text{NO}_3)_2$)

G. [3] Sodium chloride (NaCl)

H. [3] Ammonium chloride (NH_4Cl)

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] LDPE (low density polyethylene)

J. [2] PVC (polyvinyl chloride)

K. [2] PC (polycarbonate)

Fibers

L. [2] Linen

M. [2] Polyester

N. [2] Wool

Hairs

O. [2] Squirrel

P. [2] Human

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: 0.22 (B) and 0.54 (R)

[2] Andrea: 0.34 (B) and 0.68 (R)

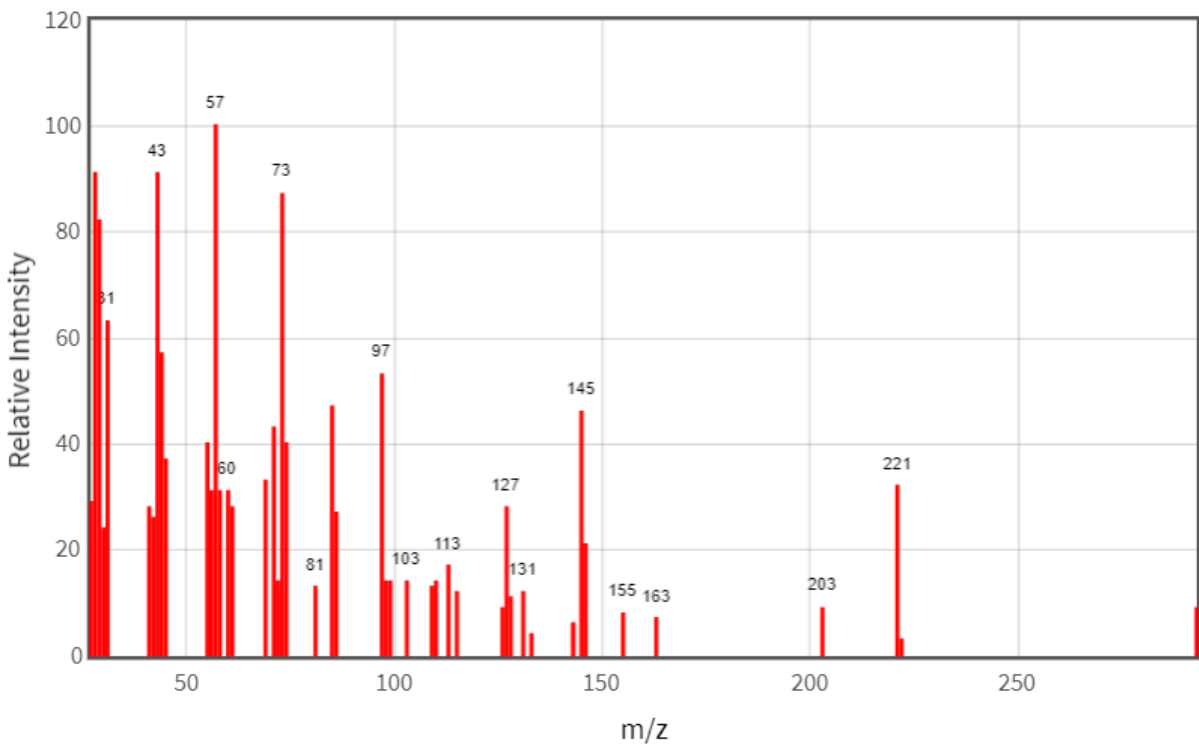
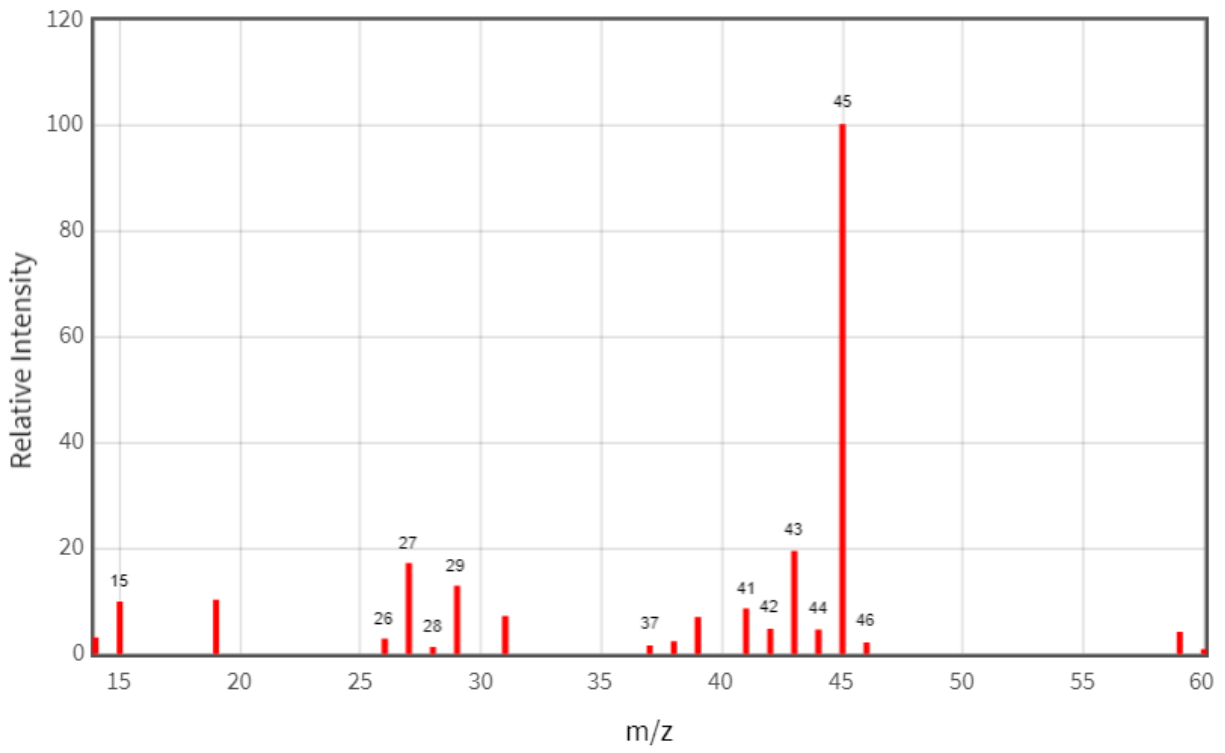
[2] What condition must be satisfied in order for Rf comparisons to be valid? (In the crime scene analysis section, you can assume that this condition is in fact true.)

Chromatography must be performed under same conditions (same solvent, same medium), ideally on same piece of paper, simultaneously.

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

[3] Top: Isopropyl alcohol

[3] Bottom: Sucrose

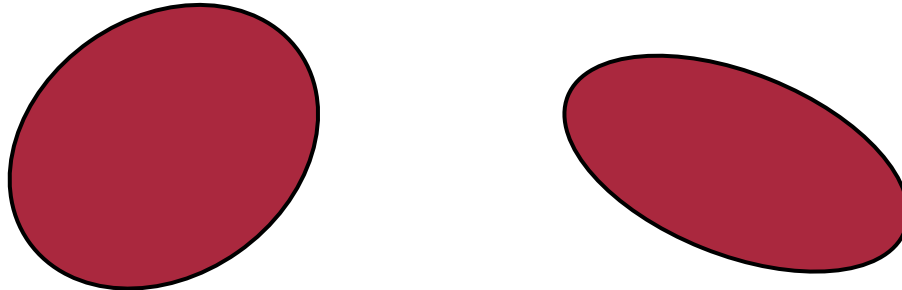


= 5 =

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: 2.1 m

[2] Right: 1.9 m

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? 1.475

[1] What type of glass is this? Pyrex (borosilicate)

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)?

Central Pocket Whorl

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

Ulnar Loop

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

Left matches Liz

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

32/17

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

$\text{AgNO}_3 + \text{NaCl (perspiration)} \rightarrow \text{AgCl}$, which turns brown with UV light because it's photosensitive

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

Height of volar pads

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? YES
<ul style="list-style-type: none">+ Calcium nitrate (reusable cold packs)+ PVC (build event)+ Linen (shirt)+ Polyester (winter coat)+ Squirrel hair (feeding squirrels) ~ PC (build event safety goggles – but also could be from safety goggles in lab)~ Fingerprints unknown - Sodium bicarbonate makes sense (burn kit)- Blood droplet height doesn't match	

SUSPECT: MARGARET	Hold for Questioning? YES
<ul style="list-style-type: none">+ Calcium nitrate (plant fertilizer)+ Polyester (athletic pants and winter coat)+ Squirrel hair (makeup brushes)+ Her marker was used to write the note ~ Fingerprints unknown - Calcium sulfate makes sense (plaster cast)- Blood droplet height doesn't match	

SUSPECT: ANDREA	Hold for Questioning? YES
<ul style="list-style-type: none">+ LiCl is out of place+ LDPE (plastic grocery bags)+ Sucrose mass spec (baking)+ Blood droplet height matches (hand over head) ~ PC plastic (glasses – but also could be from safety goggles in lab) - Rfs from note do not match- Fingerprints not found at crime scene	

SUSPECT: ADAM	Hold for Questioning? YES
<ul style="list-style-type: none">+ Ammonium chloride out of place and found at crime scene+ Wool (tweed jacket)+ Blood droplet height matches (hand over head) ~ PC plastic (glasses – but also could be from safety goggles in lab) - Fingerprints not found at crime scene	

SUSPECT: LIZ	Hold for Questioning? YES
<ul style="list-style-type: none">+ Glucose is out of place+ Wool (sweater and scarf)+ Squirrel hair (paintbrushes)+ Fingerprints were found at the crime scene - Blood droplet height doesn't match	

Screw it, everyone's suspicious.

Also, some of these things implicate nobody because they are things you'd expect to find in a lab (isopropyl alcohol, pyrex glass) on a snowy winter day (sodium chloride, which is a de-icer).

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

All according to my evil plan...