Team Number: _____

Team Name: _____

Participant names: _____

_____

# 2016-2017 **Forensics** Exam

# Princeton Science Olympiad Invitational

Instructions:
- Fill out this packet only! Only this packet will be graded.
- Hint: Focus on sections that are worth more points.

# Forensics Answer Packet
## Princeton Science Olympiad 2017

*Note: All answers need to be written in this packet. Anything written in the Information Packet will not be graded! Please write neatly.*

## I.Qualitative Analysis (42 pts)

You are given 12 samples of white powders. Use any method available to you to determine their identities, and then complete the following table, indicating each unknown's name and chemical formula.

| Powder | Name of Powder (1 pt) | Chemical Formula(1 pt) |
|---|---|---|
| A | | |
| B | | |
| C | | |
| D | | |
| E | | |
| F | | |
| G | | |
| H | | |
| I | | |
| J | | |
| K | | |
| L | | |

Answer the following questions (3 pts each).

1. List a common use of powder A.

2. List a common use of powder B.

3. List a common use of powder H.

4. List a common use of powder K.

5. Write the chemical equation of the reaction that takes place upon the addition of Benedict's solution to powder K.

6. Name and draw the crystal structure of powder D.

## II.     Plastics (41 pts)

Identify the polymers given as physical samples (2 pts each). Burn tests are **not** allowed for these plastics! Please provide the abbreviated version of the polymer names!

Feel free to use the following solutions as given:
*water, vegetable oil, isopropyl alcohol, NaCl solutions (10%, 25%, saturated)*

A.     _____
B.     _____
C.     _____
D.     _____
E.     _____
F.     _____
G.     _____
H.     _____

Identify the following polymers with their **name**, **recycling number, and should the item be recycled and/or reused** based on the picture and/or description. (3 pt each)



1.                    2.                    3.                    4.                    5.

Answer the following questions (2 pt each).

1.      Draw the monomer unit structure of polypropylene.


2.      What polymer is commonly used in shatterproof glass?


3.      Draw the monomer unit structure of the polymer from question (3).


4.      What is the full name of PETE?


5.      How does HDPE polymerize?


6.      Giving rough sketches, indicate the difference between LDPE and HDPE. **Tiebreaker**
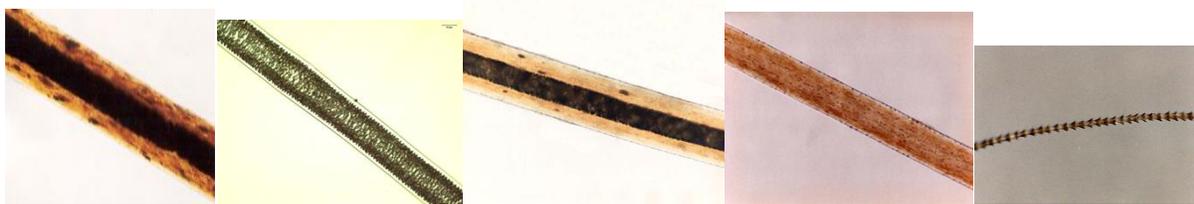
## III.     Hairs & Fibers (32 pts)

Identify the given hairs and fibers from the follow pictures. (2 pts each)

H1)_____                          F1)_____
H2)_____                          F2)_____
H3)_____                          F3)_____
H4)_____                          F4)_____
H5)_____                          F5)_____

**H1**              **H2**              **H3**              **H4**              **H5**



**F1**              **F2**              **F3**              **F4**              **F5**



Answer the following questions. (2 pts each)

1.     Name the fiber that burns with a steady flame, smells like burning paper, and leaves a charred whitish ash.


2.     Name the fiber that burns at a constant rate, does not produce smoke, and produces sparks.

3.      Name the fiber that curls, melts, produces black residue, and ignites only when brought into flame.


4.      How does one tell if a hair has been pulled out versus fallen out on its own?

5.      What is the most commonly used animal fiber?


6.      What protein is hair composed of? (Hint: this protein is also present in nails)


7.      What was the first synthetic fiber? **Tiebreaker**

IV.      **Chromatography (18 pts)**

You are given a sample of the ink found at the crime scene, as well as three possible suspect pens. Use the given TLC plate to develop a thin-layer chromatogram of these inks. Determine the Rf value of each dye and determine the whose pen was found at the crime scene. Show calculations!

Tape your TLC plate to the page below.
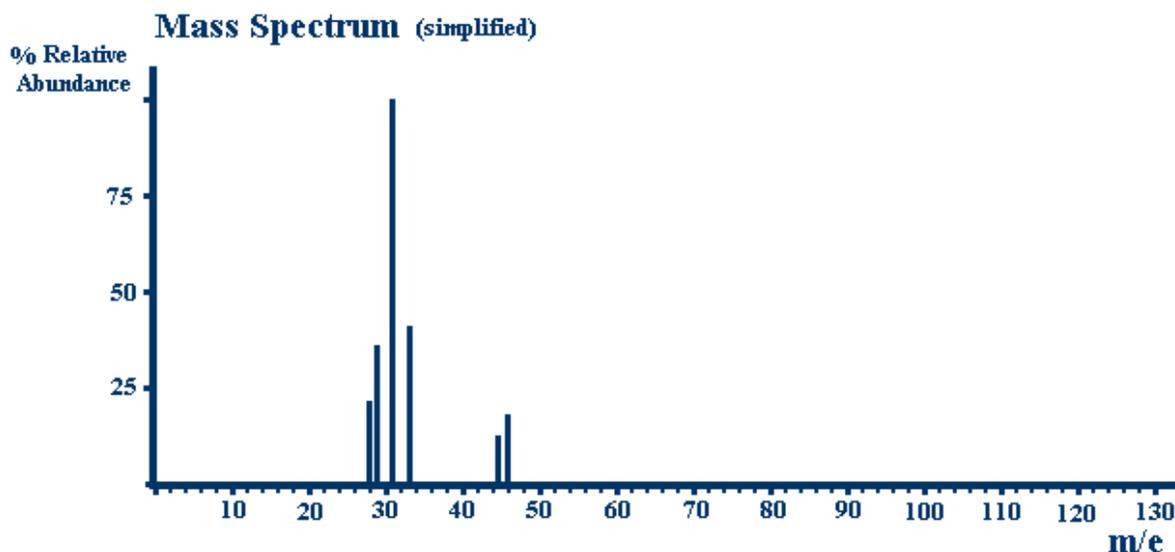
**TLC PLATE (10 pts)**

*Rf value =*

*Calculations:*

What is the stationary phase in this TLC?

_____

Whose pen was at the scene?

_____

## V.    Spectroscopy (12 pts)

*Analyze the mass spectrum given below and answer the following questions. The compound whose spectrum is shown below was found at the crime scene.*



## Questions (3 each)

1.  Which of the following particles would show the greatest deflection in a mass spectrometer (circle)?

    $C_2H_5^+$                    $C_2H_5^{2+}$                    $CH_3^+$

2.    What is the most likely molar mass of the compound shown in the above spectrum?

3.    What is the mass/charge of the *base peak*?

4.    Based on your analysis, what is the most likely compound that this mass spectrum represents? Give the molecular formula. You may find the fact that the C-13 NMR spectra shows 2 peaks to be helpful.

### VI.    Fingerprint Analysis (24 pts)

### Crime Scene (2 pts)
Use the given tape and a pencil to take the fingerprint of either team member:

What type of fingerprint do you have (arch, loop, whorl)?

### Identify Minutiae (7 pts)
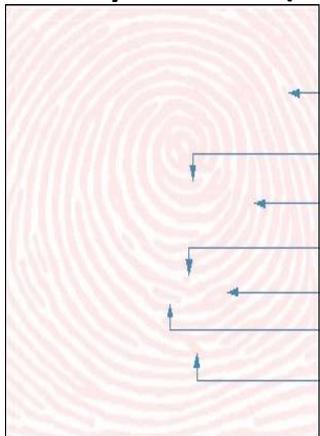


### True/False (5 pts)

1.      Fingerprints are fully formed at about 3 months of fetus development.

2.      Parent and child have no similarity in fingerprints.

3.      95% of people have fingerprints with loops or arches.

4.      There are an average 300 ridges on a finger.

5.      Patent prints have a 3D quality from pushing into a soft substance like wax or soap.
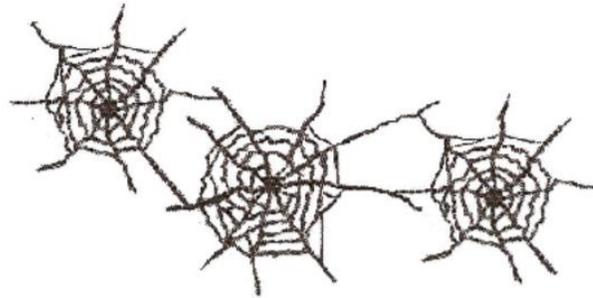
**Questions (6 pts)**
1.      What are three methods of revealing latent prints?

2.      What are three methods of taking fingerprints?

**Fingerprint Identification (4 pts)**
The following two fingerprints were found at the crime scene. Label the follow fingerprints with their patterns.



_____



_____

## VII.    Glass Analysis (8 pts)



1.In the sequence of glass fractures shown above, which shot was fired first (circle one)?

             Left                              Middle                          Right

2. Light travels from air into a shattered glass piece and has an angle of incidence of 40 degrees. The angle of refraction of the light is 23.68 degrees. Calculate the index of refraction of the glass.

3.What type of optical glass is this glass piece?

4.What is the difference between a radial and a concentric fracture?

## VIII.    Blood (20 pts)

1.  Here is a blood spatter from the crime scene. What is the angle of impact and the point of origin (height from floor)? Show all drawings and calculations. (6 pts)
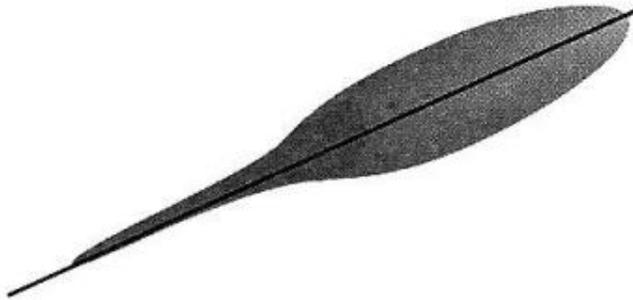


2.    Bloodstain evidence may reveal (circle all that apply): (3 pts)

a.    Origin of bloodstain
b.    Distance of bloodstain from target
c.    Direction from which blood impacted
d.    Speed with which blood left its source
e.    Position of victim and assailant
f.    Movement of victim and assailant
g.    Number of blows/shots

3.    List three methods to identify the presence of blood. (3 pts)

4.      What types of bloodstains are these and what is a possible cause (multiple answers accepted)? (6 pts)



TYPE: _____ CAUSE: _____



TYPE: _____ CAUSE: _____



TYPE: _____ CAUSE: _____

5. Complete the following (1 pt each):

Mother is type O+ and the father is A-. What are all the possibilities of the offspring's blood type (include type and Rh factor)?

Mother is A+ and the son is A+. Mother's brother is O- and mother's mother is A+. What blood type is the father?

## IX.    DNA Analysis (18 pts)

What is the difference between "class evidence" and "individual evidence"? (3 pts)

What does DNA stand for and what are the 4 components (spelling counts)? (5 pts)

Identify the component of PCR described (2 pts each):

PCR stands for _____ .

In this step, DNA is heated to break hydrogen bonds and form single-stranded DNA.

_____.

Small segment of DNA, usually 20 nucleotides long. _____.

A salt solution that stabilizes DNA and other reactions. _____.

DNA polymerase is active in this step of PCR. _____. (**Tiebreaker**)

## X. Conclusion/Analysis of Crime Scene (65 pts)

Using the evidence presented and the data given in the information packet, please determine who is responsible for the crime. Points will be awarded for all evidence and suspects correctly paired. Make sure to support any conclusions based on the evidence and reasoning.