

Forensics KEY

Clements High School

Calling all stellar forensic teams!

Trophies for the Clements 2019 Invitational have been stolen, with 50 minutes remaining until the awards ceremony! Upon investigation, it turns out that Hearty Hart, the science olympiad sponsor and trophy-watcher, was “sleeping on the job” after a long night of dealing with pre-invitational antics. As he woke, he discovered a barren room, devoid of all the glistening trophies which had once inhabited the room.

We have gathered some suspect profiles for you to analyze and crack before the start of the awards ceremony:

1. Uptown Usanga: (previous science olympiad sponsor)

Interview: “What? Trophies were stolen? You see, this is what happens as soon as you don’t have me, the best sponsor, watching over you all! This turn of events is too unfortunate... Well, I’ve been very sick with a horrible cold and cough, so I definitely do not have the energy to be dealing with your antics!”

Possible Motives: Possibly wants shiny trophies to entertain her newborn child, perhaps some hidden vengeance towards the science olympiad team...

Physicalities:



- African american
- Loves to go to the gym, gym attire is what she wears on a near daily basis
- Loves to consume energy drinks to fuel her workouts
- Has a mild case of athlete's foot, very insecure about this fact.
- B+ blood
- Loves to meal prep, has characteristic containers for her food

2. Big Bad Wolfe: (the school’s band director)

Interview: “That’s quite unfortunate. It seems that now you’ll have more time to practice your instrument!”

Possible Motives: long standing feud with the school’s science olympiad organization, wishes more people cared about the band program

Physicalities:



- Caucasian

- Wears fuzzy, mildly coarse sweater on top of normal t shirts, also wears jeans
- Loves to “enjoy a cup of steaming coffee on a chilly day”
- Loves face masks and essential body bath salts, but seem to be ineffective for her complexion
- O+ blood

3. Hearty Hart: (current science olympiad sponsor)

Interview: “We need to find the trophies soon! ”

Possible Motives: is currently disappointed with the team’s lack of motivation, possibly wants to distract the team so that he has more time to grade his physics tests

Physicalities:



- Korean
- Wears jeans on a daily basis
- Eats Salt and vinegar chips everyday for lunch along with a glass of cold frothy milk, currently in love with eating mooncakes
- class room is always in a state of disarray, complains about needing to replace his overused chalkboard
- Recently went to buy bulk order of swim noodles along with the new glue order, motives are unclear, perhaps a pool party.
- AB - blood

4. Stealthy Sameer: (current scioly president)

Interview: “Whoever did this needs to pay. I was too busy during invitational prep, no way that I had even a spare minute to steal trophies.”

Possible Motives: Possibly wants shiny trophies to himself to put on display in his house with his other trophies

Physicalities:



- Mexican
- Loves to wear joggers
- Unexpectedly soft hearted, has a garden of succulents growing on his porch, tends to them every day, also is currently attempting to make the perfect chocolate souffle.
- AB+ blood

Powders--- [___/99pts]

1. Fill in the information regarding the powders found at the crime scene.

Powder	Identify [5pts each]	Chemical formula of the powder [1pt each]	Name ONE character that this powder could implicate. (suspects, victim, all or none) [3 pts each]
1	Sodium Acetate	NaC ₂ H ₃ O ₂	hart
2	Magnesium Sulfate	MgSO ₄	wolfe
3	Potassium Chloride	KCl	none
4	Boric Acid	H ₃ BO ₃	usanga
5	Ammonium Chloride	NH ₄ Cl	sameer
6	Sodium Carbonate	Na ₂ CO ₃	hart
7	Potassium Chloride	KCl	none
8	Calcium Sulfate	CaSO ₄	hart
9	Glucose	C ₆ H ₁₂ O ₆	usanga

2. Name two common uses for all prime numbered powders. [1pt for each use]

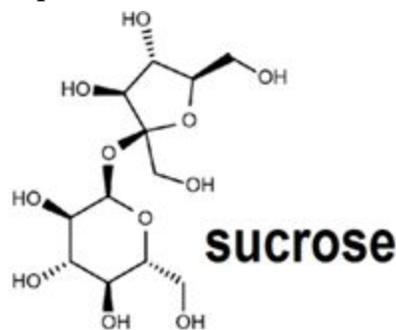
2-MgSO₄: Bath salts; flotation therapy: isolation tanks. Used for meditation, relaxation, alternative medicine; Beauty products; soothes sore muscles, splinter removal, laxatives, prevent seizures in pregnant women; agriculture, Electrolyte to prepare copper sulfate (copper anode). First aid for BaCl₂ poisoning.. Magnesium-hungry: potatoes, roses, tomatoes, lemon trees, carrots, peppers. sunscreen, skin care, treating sprains and asthma attacks, tofu coagulant, cure skin problems, beer brewing

3-KCl: Chemical feedstock—manufacture of KOH, potassium metal. Medicine, lethal injections, substitute for table salt (weak, bitter, unsalty flavor); alternative to NaCl in household water softener units. Once used as fire extinguishing agent (Super-K dry chemical) until the use of potassium bicarbonate (Purple-K) & heat packs until use of oxidation of metals or crystallization of NaH₂C₃O₂. Used in water as completion fluid in petroleum, natural gas operations. De-icing products safer for pets plants. Bottled water. CO₂ laser production

5-NH₄Cl: Nitrogen source in fertilizers (90% world production. Main crops-Asia's rice, wheat). Flux in preparing metals to be tin coated, galvanized or soldered. Expectorant in cough medicine. Produces low temperatures in cooling baths. Buffer solutions when used in ammonia.

NH₄Cl is precipitated in fossils, Covers up any coloration. Eliminates reflection on glass and similar specimens for photography. Gives large squid species neutral buoyancy in seawater. Yeast nutrient in breadmaking, spices up salty licorice, gives crispiness to food. Other: electrolyte in zinc-carbon batteries (dry cell), shampoo, cleaning products, glue that bonds plywood. medical treatments, textile printing, fertilizer, fireworks food additive, leather, explosives, safety matches, hair shampoo, glue that bonds plywood, cleaning products, deodorant, blood pH, fabric

7-KCl: Fertilizer. Chemical feedstock—manufacture of KOH, potassium metal. Medicine, lethal injections (3rd, final drug used) - stops heart, cause death by cardiac arrest), result in influx of potassium ions. Electrical impulses in cardiac muscle cells (which keep the heart running) are dependent the concentration of K⁺ and Na⁺ ion inside and outside the cell membranes. Influx of K⁺ ions disrupts this and causes the resting potential to lower below the threshold potential disabling the cardiac muscle tells to repolarize before next impulse cycle sodium-free substitute for table salt (weak, bitter, unsalty flavor); alternative to NaCl in household water softener units. Once used as fire extinguishing agent (Super-K dry chemical) until the use of potassium bicarbonate (Purple-K) & heat packs until use of oxidation of metals or crystallization of NaH₂C₃O₂. Used in water as completion fluid in petroleum, natural gas operations. De-icing products safer for pets plants. Bottled water. CO₂ laser production



3. Draw the chemical structure for sucrose. [5pts]
4. T/F: All disaccharides are reducing sugars. [1pt]
5. What element is considered a contaminant in many components and colors a flame during flame tests, what color does it taint the flame with? [1pt] **Sodium; yellow**
6. Describe how and why we can observe flame colors in a flame test. [3 pts]

When the atoms of a gas or vapor are excited, for instance by heating or by applying an electrical field, their electrons are able to move from their ground state to higher energy levels. As they return to their ground state, following clearly defined paths according to quantum probabilities, they emit photons of very specific energy. This energy corresponds to particular wavelengths of light, and so produces particular colors of light. Each element has a "fingerprint" in terms of its line emission spectrum

7. What is the formula for the precipitate formed by Epsom salts and sodium hydroxide?



Polymers--- [_____/49pts]

#	Characteristics	Polymer Name [3pts each]	Monomer formula [1pt each]	Relation to which suspect/s? [2pts each]
1	yellow flame, does not ignite/self-extinguishes; little/no smoke; plastic drips; does not char, soot, shrivels with heat. Pungent odor	Polyethylene terephthalate (PETE)	$(C_{10}H_8O_4)_n$	usanga
2	Fast burn, clean drips flame, white smoke. Not very glossy surface, scratches easily. Density $0.92g/cm^3$	Low density Polyethylene (LDPE)	$((CH_2CH_2)_n)$	hart
3	Yellow flame, burns quickly, plastic drips, illuminating gas odor (naphtha), dense black smoke w/ soot	Polysterene (PS)	$-[CH_2-CH(C_6H_5)]_n-$	wolfe
4	Fast burn, clean drips flame, white smoke. Not very glossy surface, scratches easily. Density $0.95g/cm^3$	High density Polyethylene	$((CH_2CH_2)_n)$	none

1. Describe the differences between thermosets and thermoplastics. [5 pts]

Name one thermoset and a thermoplastic from the given plastics, if there are any. [3 pts/ correct answer]

Thermoplastic: polymeric materials that are flexible @ high temp. Curing process (toughening or hardening of a polymer material by cross-linking of polymer chains, brought about by electron beams, heat or chemical additives) is reversible as no chemical bonding takes place.

Thermosets: permanently hardens w/ heat + pressure. Ideal for highheat applications (electronics, appliances). Cannot be recycled.

Thermoplastic: 3-PS

Thermosets: N/A

2. The plastic sample floats in water and rubbing alcohol, but not in oil. What is it? (2pts)

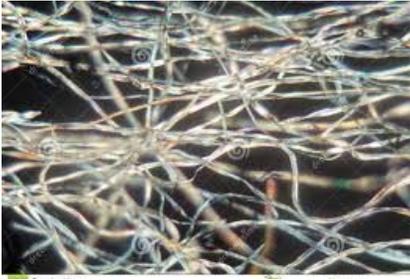
LDPE

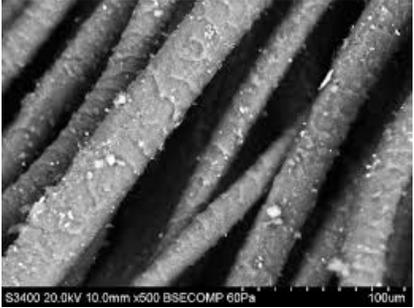
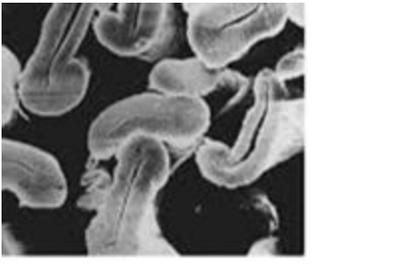
3. Give the SPI (resin code for PVC, PS, PETE, LDPE, HDPE, and PP and give an example of each use. (1pt per correct answer, 12 max)

 PETE	 HDPE	 PVC	 LDPE	 PP	 PS	 OTHER
polyethylene terephthalate	high-density polyethylene	polyvinyl chloride	low-density polyethylene	polypropylene	polystyrene	other plastics, including acrylic, polycarbonate, polyactic fibers, nylon, fiberglass
soft drink bottles, mineral water, fruit juice containers and cooking oil	milk jugs, cleaning agents, laundry detergents, bleaching agents, shampoo bottles, washing and shower soaps	trays for sweets, fruit, plastic packing (bubble foil) and food foils to wrap the foodstuff	crushed bottles, shopping bags, highly-resistant sacks and most of the wrappings	furniture, consumers, luggage, toys as well as bumpers, lining and external borders of the cars	toys, hard packing, refrigerator trays, cosmetic bags, costume jewellery, audio cassettes, CD cases, vending cups	an example of one type is a polycarbonate used for CD production and baby feeding bottles
						

Fibers/Hairs --- [] /

Specimens 1,2,3,6 were found at the crime scene.

	Image	Fiber/Hair (2pts each)	If fiber, specify kind of fiber (vegetable, synthetic, animal); if hair write "N/A" (1pt each)
1		cotton	vegetable

2	 <p>S3400 20.0kV 10.0mm x500 BSECOMP 60Pa 100um</p>	wool	animal
3		Horse	N/A
4		cotton	vegetable
5		Human	N/A
6		Human (mongoloid)	N/A

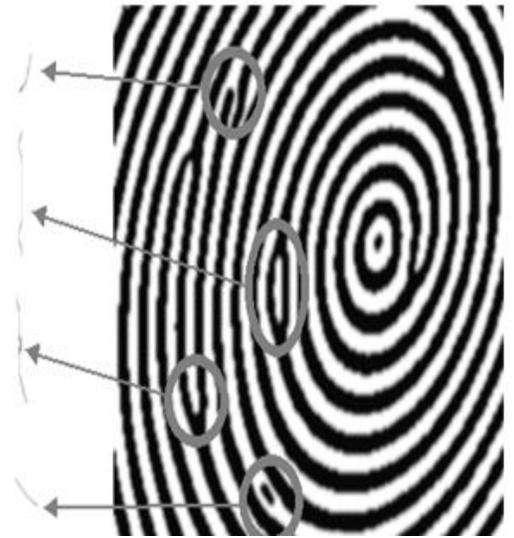
1. Describe why cotton develops its convolutions, and name the process that reduces these convolutions. [2pts for how, 1pt for process]

During the maturation stage, natural drying occurs and the walls of the fiber shrink and collapse. The central lumen also becomes smaller and flatter. These processes result in cotton's twisted shape. Process called mercerization.

2. **T/F:** The gender, but not age, can be found through microscopic examination of an individual's hair. (1pt)
3. What does the "6-6" designation mean in nylon 6-6 (2pts)?
The fiber of nylon has 2 chains of 6 carbons
4. What was the first synthetic fiber? (1pt)
Nylon

Fingerprints ---

1. What does AFIS stand for?(1pts)
 - a. **Automated Fingerprint Identification System**
2. How are friction ridges formed? (3pts)
 - a. **Formed in fetal development, fully formed within 6 months via a baby's genes and interactions w/ the walls of the womb and amniotic fluid, reason why twins can have diff fp**
3. Who was the first person to be criminally convicted based on fingerprint evidence?[BONUS3]
 - a. **Hurry Jackson**
4. Fingerprint 3 from below was found on a notecard, what development method should we use to best see/uncover this fingerprint? (2pts)
 - a. **Iodine Fuming**
5. What is the layer of skin situated just above the dermis?(2pts)
 - a. **Stratum germinativum**
6. What is the study of fingerprint identification called? (2pts)
 - a. **dactyloscopy**
7. Identify the minutiae. (2pts per minutiae)
 - a. **ridge ending**
 - b. **enclosure(lake)**
 - c. **bifurcation**



d. _____ island _____

8. The following fingerprint was found at the crime scene. Who do you think this



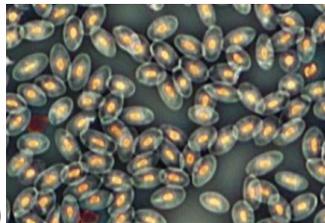
implicates? (2pts)

9. What component of a fingerprint does ninhydrin react with to develop a print? (1pt)
- Amino acids

Entomology ---

- What is ADH?(3pts)
 - Accumulated degree hour**
- What is algor mortis?(2 pts)
 - Body cooling**
- What are the stages of decomposition? (4pts)
 - autolysis(self digestion)**
 - Putrefaction (process caused by bacteria found w/in the body)**
- Which insects are the first after 24 hrs to come in contact with the carrion? (2pts)
circle one.
 - Blowflies
 - Beetles**
 - Moths
 - Fleshflies
-

Blood ---



- What kind of blood smear is this? (2pts)
 - amphibian/reptilian**
- What is erythroblastosis fetalis?(2pts)

- a. **Condition when fetus is Rh+ and mother is Rh-, causing the mother's immune system to attack the fetus. Prevent by giving the woman an injection that will suppress the immune reaction to baby.**
3. What is luminol? Why is it used in investigations? (3pts)
 - a. **A white pale yellow, crystalline solid that is soluble in most polar organic solvents, but insoluble in water. Investigators use luminol to detect trace amounts of blood at crime scenes as it reacts with the iron in hemoglobin.**
4. A blood spatter hits the ground, making a spatter that is 5.3cm long and 2.43 cm wide. Calculate the angle that it hit the ground. Show your work. (4pts)
 - a.
5. What is blood's universal donor? (1pt)
 - a. **O-**
6. What is Luminol, and how is it used in forensic application? (3pts)
 - a. Luminol is a white-to-pale-yellow crystalline solid that is soluble in most polar organic solvents, but insoluble in water. Forensic investigators use luminol to detect trace amounts of blood at crime scenes, as it reacts with the iron in hemoglobin. Chemical that exhibits chemiluminescence, with a blue glow, when mixed with an appropriate oxidizing agent.
7. How are blood types determined? (2pts)
 - a. Blood types are determined by the presence or absence of certain antigens on the surface of red blood cells.
8. This is the blood that was found at the scene. From this, who do you think this sample was derived from?



DNA ---

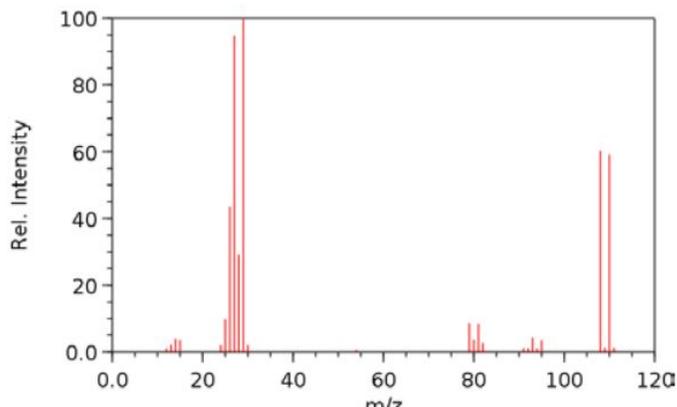
1. When was DNA fingerprinting invented? By whom? (2pts per answer)
 - a. **Alec Jeffries, 1984**
2. What is PCR? Name and briefly describe its steps. (4pts)
 - a. **Polymerase chain reaction, used to synthetically replicate DNA.**
 - b. **Denaturing (94-96 C) melting the h bonds of dna template**
 - c. **Annealing (~68C) annealing of primers, hybridization**
 - d. **Elongation/synthesis (72C) synthesizes complementary strand 5' to 3'**
3. When was DNA fingerprinting commercialized?(2pts)
 - a. **1987**

4. There were originally 5 original sequences of DNA, after 3 cycles, how many copies have been made total? Show your work. (3 pts)
 - a. $5 \cdot (2^3) = 5 \cdot 8 = 40$ copies total
5. What does VNTR stand for?(2pts)
 - a. **Variable number tandem repeats.**
6. How many molecules of DNA would be produced after 5 cycles of PCR? (2pts)
 - a. 32
7. How many STR loci has the FBI chosen to serve as the standard for CODIS?(1 pt)
 - a. 13
8. What is one difference between STR analysis and RFLP analysis? (2 pts)
 - a. STR analysis does not cut DNA with restriction enzymes, but rather, attaches probes to the desired regions on the DNA and amplifies those regions using PCR.
9. What is the difference between VNTR's and STR's? (2pts)
 - a. STR's are shorter: 2-9 base pairs compared to 10-100.
- 10.

Glass---

1. Is the glass used in cars same as window panes? If no, how is it different? Explain.
 - a. Answer – No, cars – tempered glass is used or safety glass in cars (sandwiched between plastic)Tempered glass fragments instead of splintering
2. What is the formula for calculating refractive index of glass?
 - a. The ratio of the speed of light in a vacuum to its speed in a given substance the velocity of light in vacuum/velocity of light in medium. Snells law is also right

Mass Spectrometry---



1. What is the formula of the compound displayed in the mass spectrum? (3pts)
 - a. C_2H_5Br
2. Where is the molecular ion peak located? (1 pt)
 - a. any value between 108-110 m/z, inclusive
3. Where is the base peak located? (1 pt)
 - a. 29 m/z

Analysis---

Explain who you believe is the suspect, and why. Be sure to include information on why individuals are not the suspect as well.

Hearty Hart is suspect:

- mongoloid hair
- sodium acetate from salt and vinegar chips
- sodium carbonate from mooncakes
- cotton from jeans
- calcium sulfate from chalkboard use
- AB - blood found at scene
- LDPE connected to swim noodles
- matching plain whorl fingerprint
- blood type matches that of scene

(+8)

Usanga is not suspect:

- not negroid hair
- spandex from gym attire not found at scene
- boric acid found at scene, could be linked to athlete foot treatment
- not B+ blood
- PETE found at scene, could be linked to her meal prep containers
- glucose found at scene, could have been for athlete supplement
- blood type does not match that of scene

(+7)

Wolfe is not suspect:

- not caucasian hair
- PS from her styrofoam coffee cups
- wool found at scene, connected to sweater
- MgSO₄ found at scene, connected to her face masks and body bath salts
- cotton found at scene, connected to jeans
- blood type does not match that of scene

Sameer is not suspect:

- caucasian hair does not match
- spandex was not found at scene
- ammonium chloride found at scene, fertilizer for plants
- sodium carbonate, souffle baking soda
- blood type does not match that of scene