

Name: _____

Score: _____/118

2016 Forensics Practice Test

By: Sanjana Pruthi, Natasha Badami

MURDER AT BIKINI BOTTOM!

THE CRIME

Sandy Cheeks, resident of Bikini Bottom, went to bed early to get a good night's sleep for tomorrow's karate competition. Unfortunately, she was not able to attend her competition, which she prepared very diligently for. Someone broke the glass of her dome-home, causing water to rush in. They also stole her glass fishbowl-helmet, so she did not have a way to avoid the water that painfully filled her lungs. The next morning, everyone in Bikini Bottom awoke to sirens, because an ambulance had come to Sandy's dome; however, it was too late...

Sandy Cheeks was dead.

The forensics scientists at the scene are very inexperienced, so they need your help to determine who killed Sandy Cheeks.

As a totally irrelevant side note: Catfish have cat hair, seahorses have horse hair, and dogfish have dog hair.

THE SUSPECTS

Fingerprint and DNA samples were collected from all suspects. Any additional information collected by our forensic scientists is listed below:

***Matching evidence is green; extraneous evidence is red; motivations are blue

1. Spongebob Squarepants:

- a. Spongebob Squarepants and Sandy Cheeks had been best friends for years; however, they were also rivals in karate, and both of them had registered for the karate competition. Spongebob told us that he had spent the day taking a relaxing bath with some epsom salts (MgSO_4), practicing karate with Sandy in her dome

(fingerprint), playing with Mystery the seahorse (horse hair), and looking at his dust collection. We asked him about some broken glass (heavy flint glass) we found in his house, and he told us that his magnifying glass broke while he was looking at his dust collection. (DNA doesn't match)

2. Patrick Star:

- a. Patrick is a close friend of Sandy's, but he's still salty about the fact that she didn't appreciate one of his inventions (the automatic back-scratcher, hair-comber, nose-picker, ukulele-tuner 9000). Patrick spent his day playing with a stray catfish (cat hair), drawing pictures on a rock with chalk (CaSO_4), and eating a donut (sucrose). We found some broken glass (fused quartz) in his house that he says came from a glass of kelp juice he clumsily dropped. (DNA and fingerprint don't match)

3. Squidward Tentacles:

- a. Squidward doesn't know Sandy too well and he hasn't forgiven her for fusing him to Spongebob due to a malfunction with one of her inventions. Squidward spent his day fertilizing (NH_4Cl) his kelp garden, making flour tortillas (cornstarch) playing his clarinet, and judging dogfish (dog hair) at a dogfish pageant. We found some broken glass (crown glass) in his house but he would not give us an explanation. When we asked around, neighbors told us that they had heard some terrible noise coming from Squidward's house. We concluded that Squidward was playing his clarinet so badly that his windows shattered. (DNA and fingerprint don't match)

4. Gary the Snail

- a. Gary is Spongebob's pet, and though he does not know Sandy too well, he angrily told us about this one time when "meow meow meow meow meow meow meow meow meow meow" (our expert translators, using their Snail-to-English dictionary, translated this as follows: Sandy once smashed my shell while she was practicing karate). Gary spent his day at an intense snail racing competition where he flirted with a catfish (cat hair) and knocked over the prize glass vase. The glass (crown glass) cut him, but he made sure to treat it with an antiseptic (boric acid). Later, he decided to trudge through Squidward's freshly fertilized kelp garden (NH_4Cl). (DNA matches but fingerprint does not)

THE EVIDENCE

Powders: Powder A (Boric acid), Powder B (NH_4Cl), Powder C (CaCO_3)*

Glass: A piece of broken glass from Sandy's dome (crown glass, index of refraction = 1.52)

Hairs: Some hairs were found on the nightstand where Sandy left her fishbowl-helmet (cat hair)

Fingerprints: Fingerprints were found on a piece of broken glass from Sandy's dome (Spongebob's)

DNA: A DNA sample found on the glass was run through a gel electrophoresis test (Gary's)

*CaCO₃ is meant to confuse participants; it does not implicate any suspects

Qualitative Analysis

1 pt for each correct box

24 pts total

Identify the following chemicals that were found on the suspects. Write out their chemical formulae and full names. If the chemical is a polymer, write "polymer" in the formula box. Name the person(s) the chemicals were found on.

	Chemical Formula	Name of chemical	Suspect(s) found on
1	MgSO ₄	Magnesium sulfate	Spongebob
2	C ₁₂ H ₂₂ O ₁₁	Sucrose	Patrick
3	CaSO ₄	Calcium sulfate	Patrick
4	Polymer	Cornstarch	Squidward
5	NH ₄ Cl	Ammonium chloride	Squidward, Gary
6	H ₃ BO ₃	Boric acid	Gary

Identify the following chemicals that were found at the crime scene. Write out their chemical formulae and full names. If the chemical is a polymer, write "polymer" in the formula box.

	Chemical Formula	Name of the chemical
1	H ₃ BO ₃	Boric acid
2	NH ₄ Cl	Ammonium chloride
3	CaCO ₃	Calcium carbonate

Name the suspect(s) implicated by the evidence: **2 pts for each correct name (4 pts total)**

Gary the Snail, Squidward Tentacles

Qualitative Analysis Comprehension Questions:

1. Identify the colors of the flames for the burn tests of the following compounds. Then identify the atom in the compound that gives the flame its color:

a. **1 pt for each correct box/8 pts total**

Chemical	Flame color	Atom in question
KCl	Purple	K
LiCl	Red	Li
H ₃ BO ₃	(Light) Green	B
NaC ₂ H ₃ O ₂	Yellow/Orange	Na

2. Write the balanced equation for the reaction between hydrochloric acid and sodium carbonate. **1 pt**



3. Write the balanced equations for the reactions between:

a. Glucose and benedict's reagent **1 pt**



***Certain variations will be accepted

- i. What color results from this reaction? What compound causes this color?

2 pts

Red-brown. Cu₂O.

b. Ammonium chloride and benedict's reagent **1 pt**



***Certain variations will be accepted

- i. What color results from this reaction? What compound causes this color?

2 pts

Royal blue/dark blue. Cu(NH₃)₄SO₄

***Second answer must match answer to part b

4. When a strong acid is added to a base like sodium carbonate or sodium bicarbonate, fizz appears.

a. What molecule causes the fizz? **1 pt**



- b. What is this type of reaction called? **1 pt**
Acid-base neutralization/neutralization reaction
5. Identify which chemical corresponds to each of the following uses:
a. 1 pt for each correct box/4 pts total

Chemical	Use
KCl / Potassium chloride	Lethal injection, food processing
NaC ₂ H ₃ O ₂ / Sodium acetate	Deicer, heating packs
LiCl / Lithium chloride	Car-manufacture; carbon nanotubes
Cornstarch	Food thickener; glycogen storage disease supplement

Glass Analysis (9 pts)

Glass Found at the Crime Scene:

A light beam is shined on the sample of glass from air (assumed to have an index of refraction of 1.000) at an angle of 45°. It is refracted through the glass at an angle of 27.7°. What is the index of refraction of the glass found at the crime scene? (Round your answer to the nearest hundredth)

2 pts for correct answer

1.52

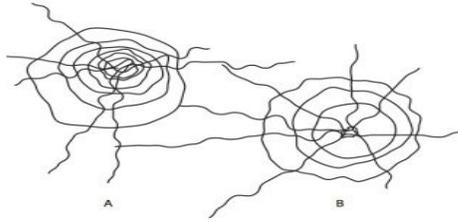
What type of glass is this sample? **1 pt**

crown glass

Name the suspect(s) implicated by the evidence. **2 pts for each correct name**

Gary the Snail, Squidward Tentacles

Upon closer examination of Sandy's dome, it was noticed that there were several fractures in the glass caused by thrown rocks, as shown below.



Which fracture, A or B, appeared first? **1 pt**

A

If the radial cracks are perpendicular to the side of the glass inside Sandy's dome, what does this indicate about how the rocks hit the glass? **1 pt**

The rocks hit the glass from the outside of Sandy's dome

Hair Identification

What animal is this hair from? **2 pts**

cat

Describe the medulla of this hair. **1 pt**

uniserial ladder

What is the typical medullary index of this animal's hair? **1 pt**

between 0.7 and 0.9 (½ credit for saying greater than ½)

Name the suspect(s) implicated by the evidence. **2 pts for each correct name**

Gary the Snail, Patrick Star

Hair Analysis Comprehension Questions:

1. If a hair sample's cuticle is coronal, which of the following animals is the hair most likely from? **1 pt**
 - a. cat
 - b. bat
 - c. horse
 - d. dog
 - e. none of the above
 2. What is typically the root-shape of human hair? **1 pt**
club-shaped
 3. Which of the following is the term for air spaces found in hair, typically near the root? **1 pt**
 - a. pheomelanin
 - b. ovoid body
 - c. granule
 - d. cortical fusi
 4. Which of the following is the phase of hair growth known as the "resting phase"? **1 pt**
 - a. telogen
 - b. prophase
 - c. anagen
 - d. chemiosmosis
 - e. metaphase
 5. Which of the following is MOST LIKELY to be a feature of hair with a round cross-section? **1 pt**
 - a. it's curly
 - b. it's wavy
 - c. it's straight
 - d. it's in its resting phase
 - e. it's in its growing phase
-

Below is the DNA electrophoresis for each of the suspects along with the electrophoresis of the sample of DNA found at the crime scene.



Name the suspect(s) implicated by the evidence. **3 pts for correct name**

Gary the Snail

DNA Comprehension Questions:

1. What does PCR stand for? What does it do? **1 pt for each answer/2 pts total**

PCR = Polymerase Chain Reaction

It is a method of synthetic DNA replication through cycles of temperature changes

2. Describe the denaturation process of PCR. **1 pt**

Two strands of DNA are separated by heating the solution to 95° C

3. What are the four nucleotides that compose DNA? **1 pt**

Adenine, Cytosine, Thymine, and Guanine

4. Which type of bonds join two nucleotides on opposite strands to form double stranded DNA? **1 pt**

Hydrogen bonds

5. Why do smaller fragments of DNA move farther through the gel filter during electrophoresis? **2 pts for correct explanation**

One end of the tray is positively charged, and DNA is negatively charged, so the DNA goes towards the tray's positive end. However, small fragments of DNA move more easily through the gel than large ones, so they move farther.

Fingerprint Matching

Fingerprints at the crime scene:

Identify the type of fingerprint pattern of the fingerprints of each of the suspects and the fingerprint found at the crime scene:

1 pt for each correct box/5 pts total

Suspect	Fingerprints	Fingerprint Type
Spongebob		Central pocket whorl

Patrick		Ulnar loop
Squidward		Tented arch
Gary		Tented arch
Crime scene		Central pocket whorl

Name the suspect(s) implicated by the evidence: **2 pts for correct name**

Spongebob Squarepants

Fingerprint Comprehension Questions:

1. Describe the difference between a central pocket whorl and a plain whorl. **1 pt**

If you draw a line through the deltas of a plain whorl, it will cross over some of the ridges twice while if you do the same for a central pocket whorl, it will only cross over each ridge once.

2. What percent of fingerprint patterns are loops? Whorls? Arches? **1 pts for each correct answer/3 pts total**

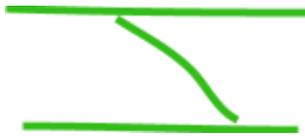
loops - 70%

whorls - 25%

arches - 5%

3. Draw the following minutiae: **1 pt for each correct drawing/3 pts total**

- a. bridge



- b. island ridge



- c. bifurcation



4. What is a common name for cyanoacrylate fuming? **1 pt**

superglue fuming

- a. What type of surface does cyanoacrylate fuming work best on? **1 pt for "nonporous"**

nonporous surfaces like metal, glass, and plastic

5. Which fingerprinting method reacts with the amino acids in the fingerprint? **1 pt**
 ninhydrin

Suspect Identification

Name the prime suspect. Note evidence that pointed to this suspect and a possible motivation:

5 pts for naming suspect

1 pt for motive

2 pt for every correct line of evidence (present at the crime scene) regardless of named suspect

16 pts total

-Gary the Snail is the prime suspect.

-Gary killed Sandy Cheeks because he was angry that she had broken his shell once while she was doing karate. He decided that he must put an end to her karate, which was most easily done by putting an end to her.

-The fingerprint analysis was the only test that didn't match up with Gary, but it did match up with his owner, Spongebob. *** **This does not count towards point total**

-The DNA test matched Gary's DNA.

-Gary used an antiseptic which contains boric acid and went through Squidward's fertilized garden which contained ammonium chloride, both of which were chemicals at the crime scene. *** **counts as four points if both ammonium chloride and boric acid are mentioned**

-Gary had cat hair on him which was found at the crime scene.

-Gary had bits of crown glass on him which were found at the crime scene.

Explain why the other suspects are not the prime suspect:

2 pts for stating there wasn't enough evidence to point to any other suspect

1 pt for stating each line of evidence for the other suspects

6 pts total

There was not enough evidence pointing to the other suspects.

Squidward tested positive for the qualitative analysis because he used fertilizer which contained ammonium chloride. He also tested positive for the glass analysis because his windows were made of crown glass. He did not test positive for the DNA, fingerprint, or hair tests.

Patrick tested positive for cat hair but he did not test positive for DNA, fingerprinting, glass analysis, or qualitative analysis.

Spongebob tested positive only for fingerprinting and nothing else.