CRIME BUSTERS PRACTICE TEST

This is the answer key.

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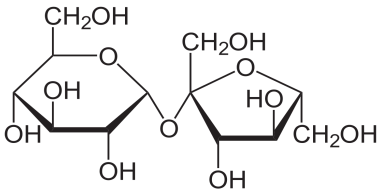
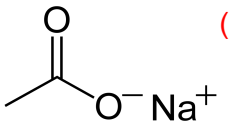
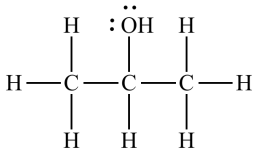
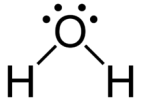
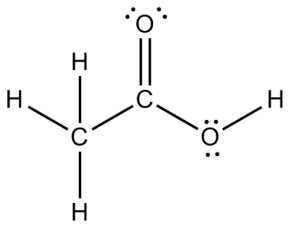
NOTE: Alyssia is NOT the culprit, but when a question asks which suspect is implicated, Alyssia can be the answer!!

QUESTIONS			
#	Question	Answer	Pts
1	What is the name of P1 (powder #1)?	Salt (1 pt)	__/1
2	What is the chemical formula of P1?	NaCl (1 pt)	__/1
3	Does P1 implicate anybody? If so, which suspect(s)? (no explanation needed)	Barry (0.5 pts, hummus and pretzel snack) Caitlyn (0.5 pts, salt to sugar ratios)	__/1
4	What is the name of P2?	Vitamin C (1 pt)	__/1
5	What is the chemical formula of P2?	$C_6H_8O_6$ (1 pt)	__/1
6	Does P2 implicate anybody? If so, which suspect(s)? (no explanation needed)	Dorthy (1 pt, gingivitis treatment)	__/1
7	What is the name of P3?	Gypsum (1 pt)	__/1

8	What is the chemical formula of P3?	$CaSO_4$ (1 pt)	__/1
9	Does P3 implicate anybody? If so, which suspect(s)? (no explanation needed)	Alyssia (0.5 pts, sculpting) Elias (0.5 pts, soil conditioner and fertilizer)	__/1
10	What is the name of P4?	Sand (1 pt)	__/1
11	What is the chemical formula of P4?	SiO_2 (1 pt)	__/1
12	Does P4 implicate anybody? If so, which suspect(s)? (no explanation needed)	Nobody (1 pt)	__/1
13	What is the name of P5?	Yeast (1 pt)	__/1
14	What is the chemical formula of P5?	N/A (1 pt, yeast is a microorganism, $C_{19}H_{14}O_2$ is the formula for baker's yeast extract though)	__/1
15	Does P5 implicate anybody? If so, which suspect(s)? (no explanation needed)	Caitlyn (1 pt, lemon cake)	__/1
16	What is the name of P6?	Flour (1 pt)	__/1
17	What is the chemical formula of P6?	$C_4H_8O_4$ (1 pt)	__/1
18	Does P6 implicate anybody? If so, which suspect(s)? (no explanation needed)	Caitlyn (1 pt, lemon cake)	__/1
19	What is the name of P7?	Baking soda (1 pt)	__/1
20	What is the chemical formula of P7?	$NaHCO_3$ (1 pt)	__/1
21	Does P7 implicate anybody? If so, which suspect(s)? (no explanation needed)	Caitlyn (0.5 pts, lemon cake) Zion (0.5 pts, cleaning)	__/1
22	What is the name of P8?	Sodium acetate (1 pt)	__/1
23	What is the chemical formula of P8?	$C_2H_3NaO_2$ (1 pt)	__/1
24	Does P8 implicate anybody? If so, which suspect(s)? (no explanation needed)	Alyssia (1 pt, heating pads)	__/1
25	What are the names of the components of P9?	Sugar (1 pt) Flour (1 pt)	__/2

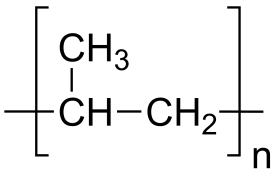
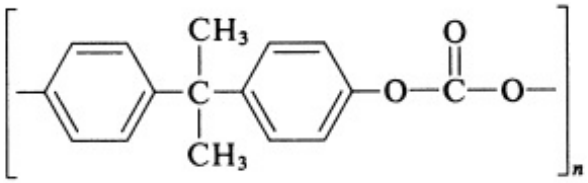
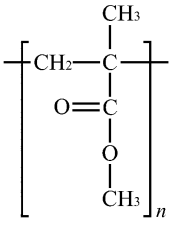
26	What are the chemical formulae of the components of P9?	$C_{12}H_{22}O_{11}$ (1 pt) $C_4H_8O_4$ (1 pt)	__/2
27	Does P9 implicate anybody? If so, which suspect(s)? (no explanation needed)	Caitlyn (1 pt, lemon cake)	__/1
28	What are the names of the components of P10?	Sugar (1 pt) Salt (1 pt)	__/2
29	What are the chemical formulae of the components of P10?	$C_{12}H_{22}O_{11}$ (1 pt) NaCl (1 pt)	__/2
30	Does P10 implicate anybody? If so, which suspect(s)? (no explanation needed)	Caitlyn (1 pt, lemon cake)	__/1
31	Write the equation of the reaction between baking soda and vinegar (include states of matter).	$NaHCO_{3\ (aq)} + HC_2H_3O_{2\ (aq)} \rightarrow CO_{2\ (aq)} + H_2O_{\ (l)} + C_2H_3NaO_{2\ (aq)}$ (1 pt for reactants, 1 pt for products)	__/2
32	What is the KI test indicative of in powders? What compound forms if this test is positive?	Starch (1 pt) I_3^- (1 pt)	__/2
33	What type of attractive forces helps salts such as NaCl dissolve in water?	Ion - dipole forces (1 pt)	__/1
34	Dissolving sodium acetate is an _____ process, meaning heat is _____.	Exothermic (1 pt) Released (1 pt)	__/2
35	Write the equation of the reaction between calcium carbonate and hydrochloric acid (include states of matter).	$CaCO_{3\ (s)} + 2HCl_{\ (aq)} \rightarrow CaCl_{2\ (aq)} + H_2O_{\ (l)} + CO_{2\ (g)}$ (1 pt for reactants, 1 pt for products)	__/2
36	Vitamin C is also called _____ acid.	Ascorbic (1 pt)	__/1
37	_____ is the species of yeast used to make bread.	Saccharomyces cerevisiae (1 pt)	__/1
38	Draw the structure of common sugar (sucrose).	 (1 pt for α-D-glucose on the left, 1 pt for β-D-fructose on the right)	__/2
39	What are the three active ingredients of Alka-Seltzer?	Aspirin, sodium bicarbonate, anhydrous citric acid (1 pt for getting 2/3, 2 pts for getting 3/3)	__/2
40	Substances like flour are carbohydrates, meaning they contain which elements?	Carbon, hydrogen, oxygen (1 pt)	__/1

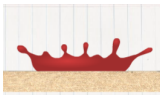
41	Draw the Lewis Dot structure of sodium acetate.	 (1 pt for correct structure)	__/1
42	What is the name of L1 (liquid #1)?	Rubbing alcohol (1 pt)	__/1
43	Does L1 implicate anybody? If so, which suspect(s)? (no explanation needed)	Dorthy (0.5 pts, disinfectant in hospitals) Zion (0.5 pts, cleaning supply)	__/1
44	What is the name of L2?	Lemon juice (1 pt)	__/1
45	Does L2 implicate anybody? If so, which suspect(s)? (no explanation needed)	Caitlyn (1 pt, lemon cake)	__/1
46	What is the name of L3?	Ammonia (1 pt)	__/1
47	Does L3 implicate anybody? If so, which suspect(s)? (no explanation needed)	Elias (0.5 pts, used as fertilizer) Zion (0.5 pts, cleaning supply)	__/1
48	Lemon juice contains what acid? What is this acid's chemical formula?	Citric acid (1 pt) $C_6H_8O_7$ (1 pt)	__/2
49	Why does rubbing alcohol evaporate much faster than water does? Draw the Lewis Dot structure of both.	Rubbing alcohol has weaker IMFs (0.5 pts) because of fewer hydrogen-bonding sites (0.5 pts).   (1 pt for rubbing alcohol [left], 1 pt for water [right])	__/3
50	The pH test measures the concentration of what ion?	H^+ ions (1 pt)	__/1
51	Draw the Lewis Dot structure of acetic acid.	 (2 pt for correct structure)	__/2
52	What is the name of M1 (metal #1)?	Iron (1 pt)	__/1

53	Does M1 implicate anybody? If so, which suspect(s)? (no explanation needed)	Nobody (1 pt)	__/1
54	What is the name of M2?	Copper (1 pt)	__/1
55	Does M2 implicate anybody? If so, which suspect(s)? (no explanation needed)	Caitlyn (0.5 pts, used for cooking vessels) Dorthy (0.5 pts, antimicrobial properties)	__/1
56	What is the name of M3?	Tin (1 pt)	__/1
57	Does M3 implicate anybody? If so, which suspect(s)? (no explanation needed)	Barry (1 pt, used for soldering)	__/1
58	Which Crime Busters metal is the most dense? What is its density?	Copper (1 pt) ~8.96 g/cm^3 (1 pt)	__/2
59	Which Crime Busters metal is the least dense? What is its density?	Magnesium (1 pt) ~1.74 g/cm^3 (1 pt)	__/2
60	Write the chemical equation for the formation of rust on iron (states of matter are not necessary).	$4Fe + 3O_2 \rightarrow 2Fe_2O_3$ $4Fe + 3O_2 + 2H_2O \rightarrow 2Fe_2O_3 \times 2H_2O$ (1 pt for reactants, 1 pt for products, both equations are valid)	__/2
61	In the reaction between magnesium and hydrochloric acid, which reactant is the reducing agent and which is the oxidising agent?	Magnesium is the reducing agent. (1 pt) Hydrochloric acid is the oxidising agent. (1 pt)	__/2
62	What type of fiber is F1 (fiber #1)?	Plant fiber (1 pt)	__/1
63	Does F1 implicate anybody? If so, which suspect(s)? (no explanation needed)	Alyssia (0.33 pts, socks), Barry (0.33 pts, jersey), Dorthy (0.33 pts, scrubs)	__/1
64	What type of fiber is F2?	Synthetic fiber (1 pt)	__/1
65	Does F2 implicate anybody? If so, which suspect(s)? (no explanation needed)	Barry (0.33 pts, jersey), Dorthy (0.33 pts, scrubs), Elias (0.33 pts, material science class)	__/1
66	What type of fiber is F3?	Animal fiber (1 pt)	__/1
67	Does F3 implicate anybody? If so, which suspect(s)? (no explanation needed)	Caitlyn (1 pt, apron)	__/1
68	Synthetic fibers are created through a process called _____.	Polymerisation (1 pt)	__/1

69	What chemical is used in mercerisation? What type of fibers are mercerised?	Sodium hydroxide (1 pt) Plant fibers (1 pt)	__/2
70	What type of hair is H1 (hair #1)?	Dog (1 pt)	__/1
71	Does H1 implicate anybody? If so, which suspect(s)? (no explanation needed)	Alyssia (1 pt)	__/1
72	What type of hair is H2?	Human (1 pt)	__/1
73	Does H2 implicate anybody? If so, which suspect(s)? (no explanation needed)	Everyone (1 pt)	__/1
74	What type of hair is H3?	Human (1 pt)	__/1
75	Does H3 implicate anybody? If so, which suspect(s)? (no explanation needed)	Everyone (1 pt)	__/1
76	What are the three stages of hair growth?	Anagen, Catagen, Telogen (1 pt for getting 2/3, 2 pts for getting 3/3)	__/2
77	The _____ of the hair contains the richest source of DNA associated with hair.	Follicular tag (1 pt)	__/1
78	What type of fingerprint is FP1 (fingerprint #1)?	Arch or tented arch (1 pt)	__/1
79	Which suspect does FP1 implicate?	Alyssia (1 pt)	__/1
80	What type of fingerprint is FP2?	Plain Whorl (1 pt)	__/1
81	Which suspect does FP2 implicate?	Caitlyn (1 pt)	__/1
82	What type of fingerprint is FP3?	Double loop (0.5 pts) whorl (0.5 pts)	__/1
83	Which suspect does FP3 implicate?	Caitlyn (1 pt)	__/1
84	What are major features of fingerprints called?	Minutiae (1 pt)	__/1
85	Describe the process of iodine fuming. (1-2 sentences but be detailed)	Iodine crystals vaporise with heat (1 pt) and produce violet fumes. Fatty or oil matter (1 pt) in the fingerprint absorb these fumes, and ridges appear yellowish brown (1 pt).	__/3

86	Describe the process of fingerprint detection with ninhydrin. (1-2 sentences but be detailed)	Ninhydrin is 2,2-dihydroxyindane-1,3-dione (1 pt) and it reacts with the α-amino group of the primary amino acids (1 pt) from the fingerprint. It turns Ruhemann's purple (1 pt).	__/3
87	Describe the process of cyanoacrylate fuming. (1-2 sentences but be detailed)	Cyanoacrylate reacts with the amino acids (1 pt) present in the fingerprint. It turns white (1 pt) as polymerised cyanoacrylate ester (1 pt) is deposited.	__/3
88	What is the difference between latent, plastic and patent prints? Name one example of each type.	Latent: not visible without additional processing (0.5 pts), examples include fingerprints left with sweat or oil (0.5 pts) Plastic: 3D impression (0.5 pts), examples include fingerprints left in paint, wax, soap or tar (0.5 pts) Patent: visible to human eye (0.5 pts), examples include fingerprints left in blood, grease, ink or dirt (0.5 pts)	__/3
89	What is the system of classifying fingerprints based physiological characteristics called?	Henry Classification System (1 pt)	__/1
90	Which suspect(s) does C1 (the chromatography test) implicate?	Caitlyn (2 pts)	__/2
91	What is the mobile phase in this chromatography test?	Isopropyl alcohol (1 pt)	__/1
92	What is the stationary phase in this chromatography test?	Paper (1 pt)	__/1
93	Which ink color is more polar based on this chromatography test?	Yellow (1 pt)	__/1
94	What does Rf stand for in terms of chromatography?	Retention factor or retardation factor (1 pt)	__/1
95	What type of plastic is PL1 (plastic #1)? (full name)	Polypropylene (1 pt)	__/1
96	Draw the recycling label of PL1.	 (0.5 pts for correct number, 0.5 pts for correct abbreviation, no pts if not drawn in the recycling label style)	__/1

97	Draw the structure of PL1.	 (1 pt for correct structure)	__/1
98	Does PL1 implicate anybody? If so, which suspect(s)? (no explanation needed)	Barry (0.5 pts, yogurt container) Dorthy (0.5 pts, medicine bottle)	__/1
99	What type of plastic is PL2? (full name)	Polycarbonate (1 pt)	__/1
100	Draw the recycling label of PL2.	 (0.5 pts for correct number, 0.5 pts for correct abbreviation, no pts if not drawn in the recycling label style)	__/1
101	Draw the structure of PL2.	 (1 pt for correct structure)	__/1
102	Does PL2 implicate anybody? If so, which suspect(s)? (no explanation needed)	Caitlyn (1 pt, glasses)	__/1
103	What type of plastic is PL3? (full name)	Polymethylmethacrylate (1 pt)	__/1
104	Draw the recycling label of PL3.	 (0.5 pts for correct number, 0.5 pts for correct abbreviation, no pts if not drawn in the recycling label style)	__/1
105	Draw the structure of PL3.	 (1 pt for correct structure)	__/1
106	Does PL3 implicate anybody? If so, which suspect(s)? (no explanation needed)	Caitlyn (1 pt, phone screen)	__/1
107	The Beilstein Test is used to detect the presence of _____ in organic compounds. It is used to identify the plastic _____.	Halogens (1 pt) PVC (1 pt)	__/2

108	Name 2 types of plastic formed by the addition polymerisation process.	Examples include HDPE, LDPE, V, PP, PS, PMMA (0.5 pts per plastic)	__/1
109	Name 2 types of plastic formed by the condensation polymerisation process.	Examples include PETE, PC, N-66 (0.5 pts per plastic)	__/1
110	Which suspect(s) blood type matches that of B1 (the blood sample)?	Caitlyn (1 pt)	__/1
111	Which blood type is the universal acceptor?	AB+ (0.5 pts for AB, 0.5 pts for +)	__/1
112	Which blood-type-determining gene is recessive?	O (1 pt)	__/1
113	Describe the process of blood detection with Luminol. (1-2 sentences but be specific)	Luminol reacts with the iron (1 pt) in blood's haemoglobin to create a bright blue luminescent glow (1 pt). It is usually sprayed (1 pt) across an area.	__/3
114	What are the names of the four stages of impact for a blood spatter? Draw a side view of each stage.	 Contact & collapse (0.5 pts for drawing, 0.5 pts for name)  Displacement (0.5 pts for drawing, 0.5 pts for name)  Dispersion (0.5 pts for drawing, 0.5 pts for name)  Retraction (0.5 pts for drawing, 0.5 pts for name)	__/4
115	What does the probative value measure?	Ability of the evidence to prove that something is related to the crime (1 pt)	__/1
116	In gel electrophoresis, macromolecules are separated based on _____ and _____.	Size (0.5 pt) Charge (0.5 pt)	__/1
117	What are the five manners of death?	Natural, accidental, homicidal, suicidal, undetermined (1 pt for 3/5, 2 pt for 5/5)	__/2
118	What is circumstantial evidence?	Evidence that implies something happened but doesn't actually prove it. (1 pt)	__/1
119	Who is the father of forensic toxicology?	Mathieu Orfila (1 pt)	__/1

#	ANALYSIS	Pts
120	Write your analysis. Questions to consider (answer other questions you come up with too): - Who is/are the culprit(s) of the dog bowls? - What evidence proves who did it? - Why are the other suspects not guilty? Other notes: - Write as much as you can! Almost everything will earn points. Make sure to be specific and clear. - Alyssia cannot be the culprit!! Grading: - Point values are shown - For the evidence against section, each piece of evidence is 0.5 pts, provided that it includes an explanation, so two pieces would be 1 pt. Both require explanations for the points though! - For example, for bullet point 1 for evidence against Caitlyn, “Salt, P1 and P10, was found, and she was experimenting with salt for her lemon cake.” is 1 pt; “Salt, P1, was found, and she was experimenting with salt for her lemon cake.” is 0.5 pts; and “Salt, P1 and P10, was found.” is 0 pts.	__/50

Caitlyn is the main suspect (8 pts).
Evidence against her (possible point values are shown and the total possible points for this section is 8.5 pts):

1. Salt, P1 and P10, was found, and she was experimenting with salt for her lemon cake. (1 pt)
2. Yeast, P5, was found, and she was baking lemon cake, which needed yeast. (0.5 pts)
3. Flour, P6 and P9, was found, and she was baking lemon cake, which needed flour. (1 pt)
4. Baking soda, P7, was found, and she was baking lemon cake, which needed baking soda. (0.5 pts)
5. Sugar, P9 and P10, was found, and she was experimenting with sugar for her lemon cake, which needed sugar. (1 pt)
6. Lemon juice, L2, was found, and she was baking lemon cake, which needed lemon juice. (0.5 pts)
7. Copper, M2, was found, and she was baking her cakes in a cooking pan. Cooking vessels are often made of copper. (0.5 pts)
8. The animal fiber, F3, implicates her because she has an angora wool apron. (0.5 pts)
9. Two of the fingerprints found, FP2 and FP3, matched her fingerprints. (1 pt)
10. The sharpie she frequently uses is the only match to the chromatography of the ink smudge found, C1. (0.5 pts)
11. PC, PL2, was found, and this plastic is used for glasses, which she has a pair of. (0.5 pts)
12. PMMA, PL3, was found, and this plastic is used for phone screens. Her phone screen is cracked and likely to leave traces. (0.5 pts)
13. The blood sample from the crime scene, B1, matches her only blood type. (0.5 pts)

Possible motives (5 pts for listing a motive for a total of 5 pts for this section, can be anything plausible and doesn’t have to be from the following list):

1. She was recently fired and is now in need of money.
2. She does not like animals.

Other supporting reasons (2 pts per supporting reason for a total of 4 pts for this section, can be anything plausible and doesn’t have to be from the following list):

1. She is easily angered and impulsive, as seen by her fit of pique.
2. She is a very messy person and is likely to leave many traces.
3. She was at her apartment at the time of the crime, meaning she had no provable alibi and she could have quickly gone to Alyssia’s apartment.
4. There is no reason for traces that are connected with her to be in Alyssia’s apartment.

Total possible points for Caitlyn: 25.5 pts

Barry is not the main suspect (2 pts).
Evidence against him (possible point values are shown and total possible points for this section is 2.5 points):

1. Salt, P1, was found, and he was eating pretzels. (0.5 pt)
2. Tin, M3, was found, and he likes to solder. Tin is oftentimes used for soldering. (0.5 pt)

3. The plant fiber, F1, and the synthetic fiber, F2, implicate him because his jersey is a cotton-and-spandex blend, and it has a small tear. (1 pt)
4. PP, PL1, was found, and this plastic is used for plastic food containers, and he was eating yogurt. (0.5 pts)

Explanations for why it is not him (1 pt per explanation for a total of 2 pts for this section, can be anything plausible and doesn't have to be from the following list):

1. Much evidence found against him could likely be from other suspects.
2. Some of the evidence found against him could be from his apartment inspections.
3. He is very organised, which means it would be unlikely for him to leave so many traces.
4. He has a stable job as an auto shop worker and apartment complex owner.

Total possible points for Barry: 6.5 pts

Dorthy is not the main suspect (2 pts).

Evidence against her (possible point values are shown and total possible points for this section is 3 points):

1. Vitamin C, P2, was found, and it is a treatment for gingivitis. (0.5 pts)
2. Rubbing alcohol, L1, was found, and it is commonly used as a disinfectant in hospitals. (0.5 pts)
3. Copper, M2, was found, and it is used as an antimicrobial agent for hospitals. (0.5 pts)
4. The plant fiber, F1, and the synthetic fiber, F2, implicate her because her scrubs are made of polyester and cotton. (1 pt)
5. PP, PL1, was found, and this plastic is used for medicine bottles, and got medicine for her kid. (0.5 pt)

Explanations for why it is not her (1 pt per explanation for a total of 2 pts for this section, can be anything plausible and doesn't have to be from the following list):

1. She is Alyssia's best friend.
2. She visits Alyssia's apartment to play with her dog, so the evidence against her could be from those visits.
3. She likes to play with Alyssia's dog, so the dog wouldn't have barked when seeing her in the apartment.
4. Her alibi can be confirmed and places her outside of the apartment complex, which means it is not likely she would have had enough time to steal the bowls.

Total possible points for Dorthy: 7 pts

Elias is not the main suspect (2 pts).

Evidence against him (possible point values are shown and total possible points for this section is 1.5 points):

1. Calcium sulfate, P3, was found, and it is used as a soil conditioner or fertilizer, and he has gardens. (0.5 pts)
2. Ammonia, L3, was found, and it is used as a fertilizer, and he has gardens. (0.5 pts)
3. The synthetic fiber, F2, implicates him because he was studying synthetic fibers in class. (0.5 pts)

Explanations for why it is not him (1 pt per explanation for a total of 2 pts for this section, can be anything plausible and doesn't have to be from the following list):

1. Alyssia's dog likes him, so the dog wouldn't have barked when seeing him in her apartment.
2. There is very little evidence against him, and all of them could have been left by someone else.
3. His alibi can be confirmed and places him outside of the apartment complex, which means it is not likely he would have had enough time to steal the bowls.

Total possible points for Elias: 5.5 pts

Zion is not the main suspect (2 pts).

Evidence against him (possible point values are shown and total possible points for this section is 1.5 points):

1. Baking soda, P7, was found, and it is used for cleaning. (0.5 pts)
2. Rubbing alcohol, L1, was found, and it is used for cleaning. (0.5 pts)
3. Ammonia, L3, was found, and it is used for cleaning. (0.5 pts)

Explanations for why it is not him (1 pt per explanation for a total of 2 pts for this section, can be anything plausible and doesn't have to be from the following list):

1. He is particular about cleaning, and it would not be likely for him to leave so many traces.
2. There is very little evidence against him, and all of them could have been left by someone else.
3. His alibi can be confirmed and places him outside of the apartment complex, which means it is not likely he would have had enough time to steal the bowls.

Total possible points for Zion: 5.5 pts
