Score Calculation

Powders: (points earned \( \div 44 \) \( \times 20 \) = _____ +

Polymers: (points earned \( \div 49 \) \( \times 20 \) = _____ +

Chromatography: (points earned \( \div 14 \) \( \times 15 \) = _____ +

Entomology + Blood + DNA + Glass + Fingerprints: (points earned \( \div 95 \) \( \times 15 \) = _____ +

Analysis: (points earned \( \div 113 \) \( \times 30 \) = _____ =

Score (scaled percentage) = _____ %
Crime Scene

As the top forensic scientist in the United States, you are often tasked with solving a wide variety of cases. You've recently been contacted by a new client looking to hire you to use your forensics skill to investigate an unusual case. Here's what the client wrote to you:

Hello,

I'm writing to ask for your help in investigating a recent tragic event. My beloved white-headed capuchin monkey, Marcel, has been stolen. A few months ago, I placed him under the care of the San Diego Zoo as I no longer had the capacity to care for him myself. However, when I went to visit him a few days ago, he was missing! When I confronted the zoo officials, they said they had reviewed the security footage around the time they believed Marcel was taken and saw five individuals near his zoo exhibit, though there wasn't any footage of the specific entry point into Marcel's exhibit (the crime scene). These five individuals happened to include all of my closest friends and my sister. I don't know why any of them would do such thing, so I'm trusting you to find out who stole my monkey. Please help me find my dear Marcel.

Ross Geller

The zoo has closed their monkey exhibit and granted you access to the scene, where you have begun your investigation.

You've collected the following evidence from the crime scene:

- Powders: answers to questions #1-8 and #14-16
- Polymers: answers to questions #22-28, #37-38, and #40-41
- Mass spectroscopy: mass spectrograph of #48 shows a substance found at crime scene
- Blood: answers to questions #52-53
- DNA: crime scene DNA is shown in #69
- Fingerprints: the complete set of fingerprints in #78

In addition to collecting this physical evidence, you have interviewed each of the suspects and taken blood, DNA, and fingerprint samples from them, which you have recorded below. Ross and Marcel are depending on your forensics skills to solve this crime, so don't let them down!

Suspects

Monica Geller:

Monica is Ross's sister. She has always been jealous of Ross because their parents have always favored him and is also extremely competitive with everyone, including Ross. She is a professional chef and likes to cook, bake, grill, etc. at home for her friends. She is also extremely organized. Monica has recently taken on the hobby of indoor gardening.

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>O+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henry System Primary Classification</td>
<td>25/18</td>
</tr>
<tr>
<td>DNA</td>
<td>![DNA Image]</td>
</tr>
</tbody>
</table>
**Chandler Bing:**

Chandler is Ross’s best friend and in a romantic relationship with Monica. He worked for many years in finance but is now working in advertising. Chandler is constantly making jokes and is often sarcastic. He says his humor stems from it originally being used as a defense mechanism to deal with his difficult relationship with his parents. These relationships also led to Chandler not celebrating Thanksgiving and occasionally smoking cigarettes.

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>A-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henry System Primary Classification</td>
<td>11/17</td>
</tr>
<tr>
<td>DNA</td>
<td></td>
</tr>
</tbody>
</table>

**Rachel Green:**

Rachel is in an on-off relationship with Ross and is Monica’s best friend. Ross and Rachel are currently “on a break” due to an argument they had. Rachel moved into Monica’s apartment after having run out of her wedding and is currently roommates with Monica. Rachel and Ross have experienced a lot together, including getting married on a whim in Las Vegas, then getting a divorce, then having a child. She works in and loves fashion and has an obsession with clothes, fabrics, shoes, etc.

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>B+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henry System Primary Classification</td>
<td>7/2</td>
</tr>
<tr>
<td>DNA</td>
<td></td>
</tr>
</tbody>
</table>

**Joey Tribbiani:**

Joey is one of Ross’s friends. He is an actor, but often struggles to find roles. He loves all food (and often overeats) but has an intense affection for jam. Joey is also very accident prone. Just the other day, he twisted his ankle severely after tripping over Ross’s foot and now can barely get out of bed. Joey stated, “I’m holding a grudge against Ross because he’s put me out of acting for at least the next couple of weeks.”

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>AB+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henry System Primary Classification</td>
<td>17/5</td>
</tr>
<tr>
<td>DNA</td>
<td></td>
</tr>
</tbody>
</table>

**Phoebe Buffay:**

Phoebe is another of Ross’s friends. She has a very unusual personal history and many unique life experiences but is sweet-natured. She has worked both as a masseuse and as a musical artist. She enjoys knitting and playing guitar at her favorite cafe. In addition, she despises the harming of animals and doesn’t wear or eat animal products.

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>O-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henry System Primary Classification</td>
<td>13/27</td>
</tr>
<tr>
<td>DNA</td>
<td></td>
</tr>
</tbody>
</table>
**Powders**  (worth 20% of score)

Questions 1-8 present a description of the physical and chemical properties of a certain powder. Identify the powder and its chemical formula.  [2 points each]

1. Hygroscopic powder, melts in flame, water soluble, pH 7, turns orange w/ Benedict’s test
   - Glucose, \( \text{C}_6\text{H}_{12}\text{O}_6 \)

2. Faint green in flame, water soluble, pH 5
   - Boric acid, \( \text{H}_3\text{BO}_3 \)

3. Fine powder, insoluble in water, black w/ iodine
   - Cornstarch, \( \text{C}_{27}\text{H}_{48}\text{O}_{20} \)

4. Green flame, water soluble, pH 6, dark blue in Benedict’s
   - Ammonium chloride, \( \text{NH}_4\text{Cl} \)

5. Red-orange sparks in flame, water soluble pH 6, precipitate in NaOH
   - Calcium nitrate, \( \text{Ca(NO}_3\text{)}_2 \)

6. Yellow flame, water soluble, pH 7, no reaction w/ HCl
   - Sodium chloride, \( \text{NaCl} \)

7. Yellow flame, water soluble, pH 8, no reaction w/ HCl
   - Sodium acetate, \( \text{C}_2\text{H}_3\text{NaO}_2 \)

8. Insoluble in water, fizz in HCl, precipitate in NaOH
   - Calcium carbonate, \( \text{CaCO}_3 \)

For questions 9-10, write the complete, balanced chemical reaction for the two reactants given.  [3 points each] 1 point for each correct product, 1 point for correct coefficients

9. Calcium nitrate and sodium hydroxide
   - \( \text{Ca(NO}_3\text{)}_2 + 2\text{NaOH} \rightarrow 2\text{Na(NO}_3\text{)}_2 + \text{Ca(OH)}_2 \)

10. Sodium bicarbonate and hydrochloric acid
    - \( \text{NaHCO}_3 + \text{HCl} \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{NaCl} \)

11. Which powders in the Forensics rules are alkaline?  [4 points] 1 point per powder
    - Sodium Acetate [\( \text{C}_2\text{H}_3\text{NaO}_2 \)], Sodium Hydrogen Carbonate/Sodium Bicarbonate [\( \text{NaHCO}_3 \)], Calcium Carbonate [\( \text{CaCO}_3 \)], Sodium Carbonate [\( \text{Na}_2\text{CO}_3 \)]
    [chemical formula unnecessary]

12. Which powders in the Forensics rules are covalently bonded?  [4 points] 1 point per powder
    - Cornstarch [\( \text{C}_{27}\text{H}_{48}\text{O}_{20} \)], glucose [\( \text{C}_6\text{H}_{12}\text{O}_6 \)], sucrose [\( \text{C}_{12}\text{H}_{22}\text{O}_{11} \)], boric acid [\( \text{H}_3\text{BO}_3 \)]
    [chemical formula unnecessary]
13. Draw a molecule of sucrose. [4 points]

Questions 14-16 give the common uses of different powders. Identify the powder and its chemical formula. [2 points each]

14. Used in crafts, casting, and cement
   Calcium sulfate, CaSO₄

15. Used in gardening; as a laxative; to control seizures, asthma, and atrial fibrillation; and in baths
   Magnesium sulfate, MgSO₄

16. Used mainly as a treatment for bipolar disorder
   Lithium chloride, LiCl

17. What are the components of Benedict’s Solution? [2 points] 0.5 points per component listed
   Copper sulfate, sodium carbonate, sodium citrate, water

18. If an aqueous solution has a pOH of 9.2, what is its hydrogen ion concentration? [2 points]
   \([\text{H}^+] = 10^{-4.8}\)

**Polymers** (worth 20% of score)

Three fibers were burned. Based on their description, label each as Animal, Vegetable, or Synthetic. [1 point each]

19. Melted and shriveled
   Synthetic

20. Shriveled only
   Animal

21. Neither shriveled nor melted
   Vegetable

Five more fibers were burned (questions 22-26). Write the name of the fiber that is most likely being described. [1 point each]

22. Smells of burning hair or feathers; burns easily
   Wool

23. Smells of celery; burns slowly; drips beads with white smoke
   Nylon

24. Smells of burning paper; burns quickly, leaves whitish ash
   Cotton
25. Smells of burning hair or feathers; slow to catch fire
   
   Silk

26. Smells of burning paper; burns slowly
   
   Linen

27. Which of the plastics specified in the Forensics rules has the has resin identification code #1? (1 point)
   
   PETE

28. Which of the plastics specified in the Forensics rules has the has resin identification code #3? (1 point)
   
   PVC

What do the following plastics stand for? Draw the monomer for each. (2 points per question) 1 point for name, 1 point for monomer

29. PETE Polyethylene terephthalate Monomer: 

30. HDPE High density polyethylene Monomer: 

31. LDPE Low density polyethylene Monomer: 

32. PP Polypropylene Monomer: 

33. PVC Polyvinyl chloride Monomer: 

34. PMMA Polymethyl methacrylate Monomer: 

35. PS Polystyrene Monomer: 

36. PC Polycarbonate Monomer: 

Questions 37 and 38 give the float test results of different polymers. Identify the polymer in each question. (1 point each)

37. Floats in water, sinks in isopropyl alcohol
   
   HDPE
38. Sinks in water, floats in sat. NaCl, sinks in 10% NaCl, sinks in 25% NaCl
PC

39. Which of the plastics from questions 29-36 are thermoplastics and which are thermoset plastics? (2 points) 1 point for stating all thermoplastics, 1 point for stating “none” or leaving blank thermosets

Thermoplastics_____ PS, PP, PVC, LDPE, HDPE, PC, PMMA, PETE ____________________________

Thermoset plastics______ none ____________________________

40. The hair to the right is from which animal? (1 point)
Squirrel

41. The hair to the right is from which animal? (1 point)
Bat

42. Draw a simple cross-sectional diagram of hair, labeling the three main layers. (4 points) 1 point per labeled layer, 1 point for drawing an accurate cross-sectional image

43. Name and describe the 4 stages of hair growth. (4 points) 1 point per stage plus description
Anagen-hair is actively growing
Telogen-hair is transitioning to resting
Catagen-hair is resting
Exogen-hair is shed
44. Draw the cross-sectional shapes of the 3 main different hair textures and label each shape with its corresponding texture. [6 points] 1 point per drawing, 1 point per correct corresponding label

![Straight Hair](image1)
![Wavy Hair](image2)
![Curly Hair](image3)

45. Name 3 human characteristics that can be determined or obtained by examining a single human hair. [3 points] 1 point per characteristic
Race, hair color, drug usage, poisoning, hair texture, etc.

Chromatography and Mass Spectroscopy [worth 15% of score]

46. To the right is the paper chromatography of an ink sample. The line near the bottom represents where the ink sample was initially placed. The blue dot also represents the level to which the solvent traveled. Calculate the Rf values of each pigment to the nearest tenth. [6 points, 1 for each value, 3 for calculations]

<table>
<thead>
<tr>
<th>Pigment</th>
<th>Rf Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>0.7</td>
</tr>
<tr>
<td>Blue</td>
<td>1.0</td>
</tr>
<tr>
<td>Yellow</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Calculations

\[
Rf = \frac{p}{s}
\]

\[p = \text{distance pigment travels}\]
\[s = \text{distance solvent travels}\]

1 point is given for the reasonable calculations of each pigment’s Rf

47. Why is the developing chamber for TLC always covered? (3 points)

The TLC chamber needs a saturated atmosphere [1 point] because without it, the solvent will start evaporating from the TLC plate [1 point], leading to an inaccurate solvent front [0.5 points] and thus and inaccurate Rf value [0.5 points].
48. Below is the mass spectrograph of a hydrocarbon. Label the base peak and molar peak. Then, identify its chemical formula and name. [5 points] 1 point each for base and molar peak, 2 points for chemical formula, 1 point for name

Chemical formula______C₃H₈________

Chemical name______propane______

Crime Scene Physical Evidence (worth 15% of score)

Entomology

49. What is the order of stages in the life cycle of a blowfly? [7 points] 1 point per stage

1 ______ Egg ______ 2 _____ 1ˢᵗ instar larva _____ 3 _____ 2ⁿᵈ instar larva _____ 4 _____ 3ʳᵈ instar larva _____

5 _____ Pre-pupa ______ 6 _____ Pupa ______ 7 _____ Adult ______

50. In what order do beetles, blowflies, and moth larvae arrive at a dead body? [1 point]

Blowfly, beetle, moth larvae

51. ______ A ______ While entomology is often used to assess how long a victim has been dead, other features of a corpse can also be used. If there are no insects in/around a corpse, but it has begun to undergo Rigor Mortis, approximately how long has the victim been dead? [1 point]

A. 2 to 24 hours.
B. 12 to 48 hours.
C. Three days to a week.
D. Unable to tell, since humans experience Rigor Mortis at vastly different rates.

Blood Analysis

52. What is the most common blood type in humans [include Rh factor]? [1 point]

O+
53. What is the least common blood type in humans (include Rh factor)? [1 point]  
AB-

54. What percentages of the population have those blood types, in the order of most common then least common? [2 points] 1 point per correct value  
Accept anything between 35 to 40% and 0.5 to 1%, respectively

55. Anti-A is added to a blood sample, which reacts with clumping. Anti-Rh is added to a different sample of the same blood, which does nothing. The hematologist testing these samples is careless, so he forgot to test the blood with anti-B. What are all the possible blood types indicated from these tests? [1 point] 0.5 points per blood type  
A- and AB-

56. What is the name of the clumping reaction mentioned in Question 55? [1 point]  
agglutination

57. What blood type is a universal donor? A universal recipient? [2 points] 1 point each  
O- and AB+, respectively

Questions 58-59 refer to the diagram below.

The blood spatter pictured above [with its dimensions and orientation labeled] was found at a crime scene.

58. What is the angle of impact of the blood spatter [calculate to the nearest tenth of a degree]? [3 points, 2 for correct answer, 1 for calculations]  
16.6°

Calculations:  
\[ \theta = \arcsin \left( \frac{W}{L} \right) \]  
\[ \theta = \arcsin \left( \frac{4}{14} \right) \]  
\[ \theta = 16.6° \]

59. Draw an arrow in the direction the blood spatter was travelling on the diagram above. [1 point]  
Arrow should be drawn from north to south on diagram
60. The slides above show (in random order) microscopic images of blood from a human, a bird, and a reptile. What type of blood does each sample show? (3 points) 1 point each

A _______ Bird _______ B _______ Human _______ C _______ Reptile _______

61. What feature of human blood cells is unique from these other blood samples? (1 point)
No nuclei in human blood cells

62. Describe the Kastle-Meyer Test and the chemical reasoning for why it works. (3 points)
The test is used to identify if a substance has blood in/on it using pH. (1 point) The indicator phenolphthalein is used because it turns pink in basic solutions (1 point), and because blood is slightly basic, a solution with blood in it will turn pink. (1 point)

63. While blood does not fluoresce under ultraviolet light without the assistance of luminol or other chemicals, why do certain other bodily fluids (e.g. saliva and semen) fluoresce under UV? (1 point)
They contain compounds that absorb the energy from ultraviolet waves and reemit it at a longer, visible wavelength
   a. What is the name of the most common fluorescing molecule in bodily fluids? (1 point) tryptophan
   b. To what class of organic compounds does the answer to 63a belong? (1 point) amino acids

DNA Analysis

64. Draw and label a simple diagram of a nucleotide. (3 points) 1 point for phosphate group, 1 for sugar, 1 for nitrogenous base

---

Phosphate group

C

S

Cytosine

Nitrogenous base

S

Sugar

Nucleotide
65. Classify A, G, C, T, and U as purines, pyrimidines, or neither. [3 points] 1 point for listing correct purines, 1 point for listing correct pyrimidines, 1 point for not listing anything under “neither”

Purines _________ A and G __________
Pyrimidines _________ C, T, and U __________
Neither _________ none __________

66. From which biological parent can one’s mitochondrial DNA be traced back to? Why? [2 points] Carried through maternal lineage (traced back to mother) [1 point] because the mitochondria in mammalian sperm are usually destroyed by the egg cell after fertilization [1 point]

67. A certain biological theory explains the origin of chloroplasts and mitochondria in eukaryotic cells. Name this theory and use it to explain why mitochondria have separate DNA from the rest of a cell’s DNA. [2 points] Endosymbiont/endosymbiosis theory [1 point]; states that a eukaryotic cell merged with a prokaryote and they developed a symbiotic relationship with the prokaryote [which has its own DNA] later becoming the mitochondria [1 point]

68. _______ Which of the following statement about chromatography and electrophoresis is TRUE? [1 point]
A. In chromatography, heavier, more-polar proteins travel farthest.
B. In electrophoresis, a sample of no more than 10 base pairs is needed for accurate results.
C. DNA electrophoresis can be used as a step to identify which species a sample came from.
D. DNA electrophoresis will 100% accurately identify the person a DNA sample came from, since no two people have exactly the same DNA [excepting identical twins].
E. All are true.

69. Which of the following is/are NOT a suitable source of DNA polymerase for PCR: T. aquaticus, P. furiosus, E. coli? Why not? [2 points] 1 point for identification, 1 for explanation E. coli; DNA polymerase from E. coli is not thermostable enough for the high temperatures of PCR

70. Which of the suspects’ DNA [find in suspect info] matches the crime scene DNA [to the right]? [1 point]
Monica Geller

71. Rank these DNA bands produced by gel electrophoresis from smallest [1] to largest [6] molecular weight. [3 points] 0.5 points per correct letter

1____F____2____C____3____E____4____D____5____B____6____A____

72. In what direction does the charge in gel electrophoresis run, starting from where the wells are loaded?

From _______ negative _______ to _______ positive _______. [2 points]
73. What is the cDNA sequence that corresponds to a strand of mRNA that reads: AUGCUGCU? (2 points)
TACCCGTAGGA

74. List the steps, temperatures, and explanations for each step of PCR. (9 points)
Denaturing-separation of DNA into two single strands, temp of 90-100 C
Annealing-when primers bind complementary sequences to single stranded DNA, temp of 30-65 C
Extension/Elongation-when DNA polymerase attaches to primers & creates a complementary copy of target sequence, temps 60-75 C

75. Label the components involved in DNA replication in the diagram below. (5 points)

A__________________DNA polymerase__________________B__________________Okazaki fragment__________________
C__________________Helicase__________________D__________________Leading strand__________________
E__________________Lagging strand__________________

76. What class of organic molecule is component A in the diagram above? What is its function? (3 points)
Protein (1 point); copy one strand of DNA into two DNA strands (1 point) by pairing nucleotides to bases present on each strand of the original DNA molecule (1 point)

Glass Analysis

Questions 77 and 78 refer to the pictures below.
77. The picture above labeled A shows a baseball bat hitting (most likely) what type of glass: laminated, borosilicate, or leaded? [1 point]
Laminated glass

78. In the picture above labeled B, which hole was created first, the left or the right? Why? [2 points]
Right (1 point); the cracks from the right stop the later cracks from the left (1 point)

Fingerprints

79. Fill in the chart below based on the Henry Classification System using this set of fingerprints. Then, calculate the fingerprints’ primary classification, also based off the Henry System. [8 points, 0.5 points per correct value on chart, 2 points for correct primary classification, 1 point for showing calculations]
**Primary classification** ______25/18______ (must be this exact fraction, can’t be decimal or simplified)

Calculations:
Primary classification = numerator value / denominator value = 25/18
Numerator value = (sum of all even finger values) + 1 = (16 + 8) + 1 = 25
Denominator value = (sum of all odd finger values) + 1 = (16 + 1) + 1 = 18

80. Label these types of fingerprints as **patent, latent, or plastic**. Define each type. (6 points) 1 point per correct type, 1 point per correct definition (awarded as long as the definition matches the type, regardless of whether or not the fingerprint type ID was accurate)
81. When developing latent prints, why might it NOT be a good idea for dusting be used as the first method? [2 points]

Powders can contaminate evidence [1 point] & ruin opportunity to perform other techniques [1 point] that could turn up a hidden print or additional information
82. Identify each of the following patterns of fingerprints. Assume all prints were from suspects' left hands. (4 points total, 0.5 points each)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Fingerprint</th>
<th>Pattern</th>
<th>Sample</th>
<th>Fingerprint</th>
<th>Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td><img src="image1" alt="Fingerprint" /></td>
<td>Accidental whorl</td>
<td>E</td>
<td><img src="image2" alt="Fingerprint" /></td>
<td>Ulnar loop</td>
</tr>
<tr>
<td>B</td>
<td><img src="image3" alt="Fingerprint" /></td>
<td>Central pocket loop</td>
<td>F</td>
<td><img src="image4" alt="Fingerprint" /></td>
<td>Arch</td>
</tr>
<tr>
<td>C</td>
<td><img src="image5" alt="Fingerprint" /></td>
<td>Double loop whorl</td>
<td>G</td>
<td><img src="image6" alt="Fingerprint" /></td>
<td>Whorl</td>
</tr>
<tr>
<td>D</td>
<td><img src="image7" alt="Fingerprint" /></td>
<td>Radial loop</td>
<td>H</td>
<td><img src="image8" alt="Fingerprint" /></td>
<td>Tented arch</td>
</tr>
</tbody>
</table>
83. ______A____ Which of the following is TRUE about fingerprints? [1 point]
A. Fingerprints form during gestation, with ridges determined by how and what the fetus is touching in the womb.
B. Genetics seems to have no impact on fingerprint formation, which is exemplified by the fact that diabetics have no marked difference in fingerprint patterns.
C. Formation of fingerprints is controlled exclusively by genetics, which is why identical twins have identical fingerprint patterns.
D. Fingerprints are not fully developed until after birth, sometimes as late as two years of age.

84. ______D____ Similar to the prints of fingers, what other human body parts can be used to identify people? [1 point]
A. Ear prints.
B. Teeth.
C. Tongue prints.
D. All of the above.
E. None of the above.

85. The value of fingerprints in forensic science is described through Locard’s Exchange Principle. Explain this principle. [1 point]
Whenever two objects come in contact, there is always a transfer of material OR perpetrator will bring something to & leave something at crime scene

Analysis (worth 30% of score)

86. Who committed the crime? Why? [113 points]

Mentioning that it was probably Monica who committed the crime is worth 20 points. [20 points max]

Mentioning that Joey was possibly also involved in committing the crime is worth 10 points. [10 points max]

Pointing out the abundance of/lack of evidence pointing towards a suspect is worth 2 point per suspect. [10 points max]. E.g.
- Monica: DNA, fingerprints, glucose, cornstarch, sodium chloride, calcium nitrate, calcium sulfate, magnesium sulfate, butane
- Chandler: very little evidence; ammonium chloride
- Rachel: very little evidence; fibers
- Joey: glucose, sodium acetate, calcium carbonate, magnesium sulfate
- Phoebe: no evidence

Describing a motive/lack of motive for each suspect is worth 2 point per suspect. [10 points max] The following are only examples of POSSIBLE motives. Competitor answers outside of these, if creative and based off suspect information, are acceptable.
- Monica: jealousy of Ross due to parents favoring him
- Chandler: being Ross’s best friend means it’s less likely it was him
- Rachel: mad at Ross because of their argument
• Joey: mad at Ross after tripping over his foot
• Phoebe: having no grudges against Ross and despising the poor treatment of animals makes it less likely to be her

Each mention of a correct piece of crime scene evidence is worth 1 point. (25 points max)

- Glucose
- Cornstarch
- Sodium chloride
- Boric acid
- Ammonium chloride
- Calcium nitrate
- Sodium acetate
- Calcium carbonate
- Calcium sulfate
- Magnesium sulfate
- Lithium chloride
- Wool
- Nylon
- Cotton
- Silk
- Linen
- PETE
- PVC
- HDPE
- PC
- Butane
- O+ blood
- AB- blood
- DNA
- 25/18 Henry System primary classification

Each reasonable connection/disconnection of one of the crime scene powders to/from a suspect/to the crime scene is worth 2 points. (22 points max) The following are only examples of POSSIBLE connections. Competitor answers outside of these, if logical, are acceptable.

- Glucose: Monica (likes to bake/cook); Joey (loves jam)
- Cornstarch: Monica (likes to bake/cook)
- Sodium chloride: Monica (likes to bake/cook)
- Boric acid: doesn’t implicate anyone
- Ammonium chloride: Chandler (smokes cigarettes)
- Calcium nitrate: Monica (likes gardening and calcium nitrate is found in plant fertilizer)
- Sodium acetate: Joey (hurt his ankle, so he’s probably using a hot pack for it, which contains sodium acetate)
• Calcium carbonate: Joey (he overeats often so he probably takes antacids often, which contain calcium carbonate)
• Calcium sulfate: Monica (likes gardening and calcium sulfate is found in plant fertilizer)
• Magnesium sulfate: Monica (likes gardening and magnesium sulfate is found in plant fertilizer); Joey (hurt his ankle, so he’s probably using Epsom salt as a treatment, which is magnesium sulfate)
• Lithium chloride: doesn’t implicate anyone

Connecting the mass spec. substance, butane, to Monica (likes to grill) is worth 2 points. [2 points max]

Explaining how all the fibers could implicate Rachel (her fashion job/interest) is worth 2 points. Stating that the wool and silk don’t implicate Phoebe (doesn’t use/wear animal products) is worth 2 points. [4 points max]

Noting that the crime scene plastics implicate none of the suspects is worth 2 points. [2 points max]

Noting that the squirrel and bat hair are not connected to any suspect is worth 1 point. Noting that they are probably there because they were carried into the monkey exhibit from another part of the zoo is worth another 1 point. [2 points max]

Noting that the crime scene DNA is that of Monica’s is worth 2 point. [2 points max]

Noting that the crime scene O+ blood matches that of Monica’s is worth 2 points and noting that the crime scene AB- blood matches that of none of the suspects is worth 2 points. [4 points max]