Name:_____Class:_____Date:_____

The Case of Kirsten K.:
The Chemical Evidence

All Reports are to be filed using the correct format, following the Lab Report Style Guide

Part I: The Delivery Truck and Crime Scene Evidence

Case Background

Based on the evidence from the cooler sample, police have started looking for the victim at the lake you had specified. Police have scanned the area indicated, and you have been called to do further tests on samples found from what police believe to be the crime scene (even though the victim's body has not been found yet) to present new information about the victim and suspects. After analyzing the crime scene samples, you have found what could be important chemical evidence that may link the suspects to the crime scene. There were five distinct residues that were found and the percentage of each element found in them is listed below in Table 1.

Table 1: Percentage of each Element found from the Chemical Evidence

Abandoned Delivery Truck	**C**	**H**	**N**	**O**
Chemical A	63.15 %	5.30%	---	31.55%
Crime Scene	**C**	**H**	**N**	**O**
Chemical B	63.15 %	5.30%	---	31.55%
Chemical C	67.31%	6.98%	4.62%	21.10%
Chemical D	60.00%	4.48%	---	35.53%
Chemical E	49.48%	5.15%	28.87%	16.5%

Purpose

Your investigation should help police to determine if the chemical analysis matches any of the suspects to the crime scene and how they may or may not be linked.

Procedure

Use the information provided to complete the following steps:

1. From the percentages listed in Table 1, find the formula for each of the Chemicals A-E.
2. Using Table 2 below and the percent compositions given in Table 1, determine the chemicals found on the victim.
3. If no match can be found, mark the chemical as unknown.

Data

Table 2: Possible Compounds Matches*

Compounds	Chemical Formula	Everyday Uses
Acetaminophen	$C_8H_9NO_2$	Painkiller (Tylenol)
Almond	C_7H_6O	Flavoring
Aspartame	$C_{14}H_{18}N_2O_5$	Artificial sweetener
Aspirin	$C_9H_8O_4$	Pain killer
Cocaine	$C_{17}H_{21}NO_4$	Narcotic, illegal
Codeine	$C_{18}H_{21}NO_3$	Painkiller, prescription controlled
Curare	$C_{40}H_{44}N_4O$	Poison
Ibuprofen	$C_{13}H_{18}O_2$	Pain killer
Nitroglycerine	$C_3H_5N_3O_9$	Explosive, heart medication
Trinitrotoluene	$C_7H_5N_3O_6$	Explosive (TNT-dynamite)
Vanilla	$C_8H_8O_3$	Flavoring

Analysis-Calculations

1. Show calculations for finding the chemical formula for each compound:

Chemical A:_____

Chemical B:_____

Chemical C:_____

Chemical D:_____

Chemical E:_____

**Data table 2 adapted with permission from the Journal of Chemical Education*, April 2003, *80*(4), 407-408

2. Calculate the empirical formula for any unknown substances:

Conclusion

List each of the chemicals and explain why you might expect to find each of these chemicals at the crime scene. This information should be based on the location of the crime scene given to police based on the evidence collected in the previous assessment.

Part II: The Suspect Evidence

Background Information

Subsequent chemical analysis of clothing, blood, and skin samples from the four suspects and a piece of clothing believed to have belonged to the victim revealed the following information provided in Table 3.

Data

Table 3: Percentage of each Element found in the Chemical Evidence from Each Suspect

	C	H	N	O
Victim	63.15 %	5.30%	---	31.55%
Suspect #1	60.00%	4.48%	---	35.53%
Suspect #2	67.31%	6.98%	4.62%	21.10%
Suspect #3	32.43%	2.70%	---	64.87%
	63.56%	6.00%	9.27%	21.17%
Suspect #4	15.87%	2.22%	18.15%	63.41%
	49.48%	5.15%	28.87%	16.5%

Analysis

1. Show calculations for each of the chemicals found for each of the suspects below:
   Victim _____

   Suspect #1 _____

   Suspect #2 _____

   Suspect #3 _____ _____

   Suspect #4 _____ _____

2. Calculate the empirical formula for any unknown substances:

Conclusion

Determine if there is a connection between the chemicals found on the suspects in Part II and the information gained from the chemical analysis in Part I.

Part III: The Amount of Chemical Substance

Background Information

Before the chemicals can be analyzed any further, the amount of each chemical found at the crime scene and from the suspects needs to be converted to the number of moles of each substance. You should be able to calculate the moles of each substance based on the following information in Table 4.

Data

After calculating the number of moles of each substance, fill in the data table with the correct amount.

Table 4: Amount of Chemical Substance from Crime Scenes and Suspects

Abandoned Delivery Truck	**Amount Found**	**Moles**
Chemical A	0.250 mg	
Crime Scene	**Amount Found**	**Moles**
Chemical B	0.004 kg	
Chemical C	1.35 mg	
Chemical D	0.02 g	
Chemical E	0.8 g	
Victim and Suspects	**Amount Found**	**Moles**
Victim	0.03 g	
Suspect #1	0.09 g	
Suspect #2	2.5 mg	
Suspect #3	0.06 g	
	1.2 mg	
Suspect #4	0.05 g	
	0.001 kg	

Conclusion

Which amounts were you unable to calculate and why? What does having an unknown mean for the investigation?

Part IV: The Cake Shop Ingredients Analysis

Background Information

After analyzing the chemicals further, it has been determined that some of the chemicals found at the crime scene (where the victim was believed to have been at one point) and on suspect #3 could have derived from the cake shop where both were employed. Further investigation shows that the day before the murder, the victim and suspect #3 were fully booked with requests for wedding cakes.

Data

The cake shop, in order to keep their recipes secret, synthesizes their own vanilla flavoring for their cakes based on the following reaction:

$$\underset{\text{(guaiacol)}}{C_7H_8O_2} + \underset{\text{(glyoxylic acid)}}{C_2H_2O_3} \rightarrow \underset{\text{(vanilla)}}{C_8H_8O_3} + H_2O$$

To verify the reaction done in the cake shop, the CSI chemical lab has simulated the experiment. They used 4.2 grams of guaiacol and 6.8 grams of glyoxylic acid.

Analysis

Using the information given, do the following calculations:

1. Show the balanced equation below.

2. Determine the limiting reactant.

3. Determine the theoretical yield of vanilla.

4. A 4.85 gram sample of vanilla was produced from the reaction in the CSI chemical lab. Based on this information, calculate the % yield by comparing the experimental amount to the theoretical amount.

5. Does the chemical % composition of the excess reagent match any of the unknowns from part one or part two? If so, identify the unknown(s).

Conclusion

Determine the connection, if any, between the unknowns and the crime scene. What else can you conclude about the case from the evidence presented through the calculations and from the new suspect information?