

Name: _____ Date: _____ Period: _____

Who Tagged the Lab Bench? Lab

Engage

Objective

At the end of class, the teacher noticed fresh tagging on one of the lab benches. There were five students sitting at the bench and each student had a different pen. Once the tagging was observed, the teacher immediately confiscated all of the pens and wrote down which student had which pen. Your task is to determine who tagged the lab bench.

Explore

Pen ink is a solution. Although many inks appear to be the same color of blue, the reality is that the blue or black color is achieved by blending a specific mixture of dye molecules. Each ink formulation is specific for the manufacturer. Forensic scientists can study the chemical makeup of pen ink to determine what type of pen a sample came from. Dye molecules can be polar or non-polar in nature.

1. **What is a solution?**
2. **What must be added together to create a solution?**

Ink can be used on many different surfaces, so it is important to consider what type of surface the ink will be used on as well as how permanent the ink should be. For example, children's markers are often washable; meaning that they can be easily washed away with water. However; an artist might not want their precious work to wash away. Chemists often use sharpie markers to write on test tubes to identify their samples and they would not want their labels easily removed. Therefore dye molecules can be polar or non-polar in nature, depending on what purpose the ink will be used for.

Background

3. **What type of solvent do you predict is used in children's washable markers? Justify your answer with evidence.**
4. **What type of solvent do you predict is used in the Sharpie markers used by chemists? Justify your answer.**

Chromatography is a technique used by chemists to take a sample solution and separate it. There are several types of chromatography that are used depending on what type of sample solution that needs to be separated: liquid chromatography, gas chromatography, paper chromatography, and thin-layer chromatography. While each type of chromatography uses different methods to separate compounds, they all share the same principle. Molecules in the sample solution must choose what they like better, *the paper or the solvent*.

5. **What type of molecule(s) will be attracted to a polar solvent?**
6. **What type of molecule(s) will be attracted to a non-polar solvent?**

If the sample molecule prefer the paper, then the sample molecule will not move. However; if the sample prefers the solvent that is used, it will be dissolved by the solvent and then will travel up the paper with it. How far the sample molecules move up the filter paper depends on how much they like the solvent.

In the chromatography strip at the right, the bottom line is the origin. The top line shows how far the solvent traveled. A non-polar solvent was used.

7. Which molecule(s) was polar? Justify your answer.

8. Which molecule(s) was non-polar? Justify your answer.



Image: Heather Vernon

Materials

- Solvent (1:1 Isopropyl Alcohol: Water)
- filter paper strip
- hair dryer
- pencil
- 4 pens to sample
- tape
- beaker

Procedure

1. Take a clean filter paper strip and using a straightedge, draw a straight line ~ 2 cm from the bottom using a pencil.
2. Using a pencil, label your samples A, B, C, and D. See Table 1 and Figure 1.

| Table 1 |
|-----------------|
| A. BIC |
| B. CaseMate |
| C. PaperMate |
| D. Center Stage |

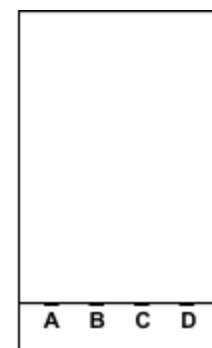


Figure 1: Image by Heather Vernon

3. Use each pen to make a 0.5-1.0 cm line on top of your origin line. See Figure 1.
4. Test out your setup BEFORE you add solvent. Make sure that the bottom of the filter paper touches the liquid in the bottom, BUT **make sure that the liquid does not touch the line**. Use tape to attach the filter paper to the pencil so the filter paper hangs freely. See Figure 2.
5. Once your setup is good, pull the filter paper out. Then add a small layer of solvent. Carefully put the filter paper back in. **Make sure that the liquid does not touch the line.**
6. Allow the chromatography to run until the solvent line is about 2 cm from the top of the paper. Use the pencil to mark the solvent line on the filter paper strip. Use the hairdryer to fully dry the filter paper.

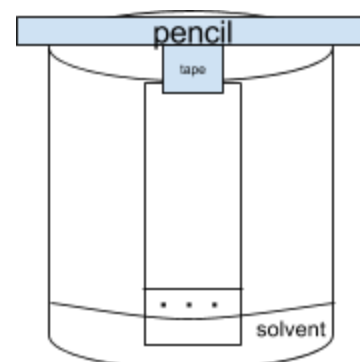


Figure 2: Image by Heather Vernon

Explain

Data

Record your data.

Record at least 4 observations.

| |
|--|
| |
| |
| |
| |
| |

Elaborate

Share with other groups your process and your results. How do the results of all of the groups in class compare to each other?

You have created a model scientists call a **standard** to show how the four types of pens separate using paper chromatography. While you were doing this, your teacher was able to take a sample of the ink from the tagging and run it through paper chromatography using the same solvent. Sketch the results of the chromatography strip. Then record at least 2 observations.

| |
|--|
| |
| |
| |
| |

Evaluate

Conclusion

The Dean and the Student Resource Officer (SRO) have been eagerly awaiting the results of your lab to know who to hold responsible for the tagging in the room. Based off of your work today, you have two choices:

- If you are sure of the identity of the tagger, then **write a referral to the Dean of Discipline explaining your evidence and how it proves that THIS student tagged the desk.** Consequences for tagging can include being suspended from class, getting a ticket and a court date from the SRO, having to pay for damages, and/or being placed on probation.
- If you are not sure of the identity of the tagger, then **write an email to the Dean of Discipline explaining why you cannot identify the tagger and explain the evidence you collected in lab.**

CHEMISTRY RULES

YOUR HIGH SCHOOL

DISCIPLINE REFERRAL FORM

Student's Name _____ Stu # _____ Grade _____ Period _____ Time _____

STAFF MEMBER MAKING REFERRAL: _____

REASON FOR REFERRAL: (Please check if the appropriate and include description)

- | | |
|--|--|
| <input type="checkbox"/> Defiant Behavior | <input type="checkbox"/> Profanity |
| <input type="checkbox"/> Dress Code Violation | <input type="checkbox"/> Vandalism/Destruction of Property |
| <input type="checkbox"/> Explosive Devices | <input type="checkbox"/> Verbal altercation |
| <input type="checkbox"/> Extortion/Robbery/Stealing | <input type="checkbox"/> Cheating |
| <input type="checkbox"/> Fighting/Assault | <input type="checkbox"/> Drop for tardies |
| <input type="checkbox"/> Left campus without permission | <input type="checkbox"/> Excessive Talking |
| <input type="checkbox"/> Left class without permission | <input type="checkbox"/> Failure to return notice |
| <input type="checkbox"/> Possession of dangerous object | <input type="checkbox"/> Inappropriate Behavior with sub |
| <input type="checkbox"/> Possession/use of drugs/alcohol | <input type="checkbox"/> Not follow directions |
| | <input type="checkbox"/> Throwing objects |

Summary of Teacher's Efforts to Solve Problem:

- | | |
|--|--|
| <input type="checkbox"/> Private conference with student | <input type="checkbox"/> Parent/teacher conference |
| <input type="checkbox"/> Telephone call to parent | <input type="checkbox"/> Progress report |
| | <input type="checkbox"/> Other: |

DESCRIPTION OF SITUATION:

At the end of class, tagging was observed on the lab bench. The pens for all 4 students sitting at the lab bench were confiscated. To determine which pen was used to tag the desk, _____

After comparing the results on the chromatography strips, it was determined that

ACTION TAKEN (by admin):

Counselor: _____

Who is the Tagger? - Message (HTML) REVIEW ADOBE PDF

MESSAGE INSERT OPTIONS FORMAT TEXT ? [Icons]

FILE Send dean of discipline Who is the Tagger?

To... Cc... Subject

Dear Dean of Discipline,

At the end of class, tagging was observed on the lab bench. The pens for all 4 students sitting at the lab bench were confiscated. To determine which pen was used to tag the desk, _____

After comparing the results on the chromatography strips, it was determined that the identity of the tagger could not be determined at this time.

Evidence for this conclusion includes _____

Sincerely,

Name: _____ Date: _____ Period: _____

Who Tagged the Bench? Lab...Investigation Two

Engage

All of the discipline referrals and emails completed yesterday were given to the Dean and the Student Resource Officer (SRO). After reading all of the class's work, the Dean and SRO are not convinced that we have identified the tagger for sure. At this point, they are not able to hold anyone accountable.

Objective

Scientists often have access to different and better equipment and technology. After discussing this with Dr. Bauer, who is a chemistry researcher at Whittier College, she suggested that we use spectroscopy. Your task is to use the spectroscopy to identify the tagger and to communicate the Dean and the Student Resource Officer (SRO) of your claim and the evidence to support it.

Background

Spectroscopy will expose a liquid sample to light. The light will either transmit (go straight through) the sample or it will be absorbed by the molecules in the sample. The spectrometer then records how much of the light was absorbed and at what wavelength. The computer program used (Logger Pro3) will then graph absorption versus wavelength. This graph is called a spectra and it is characteristic for each atom or molecule. In other words, the spectrum is like a fingerprint for the atom or molecule.

Explore

Analyze the spectra below.

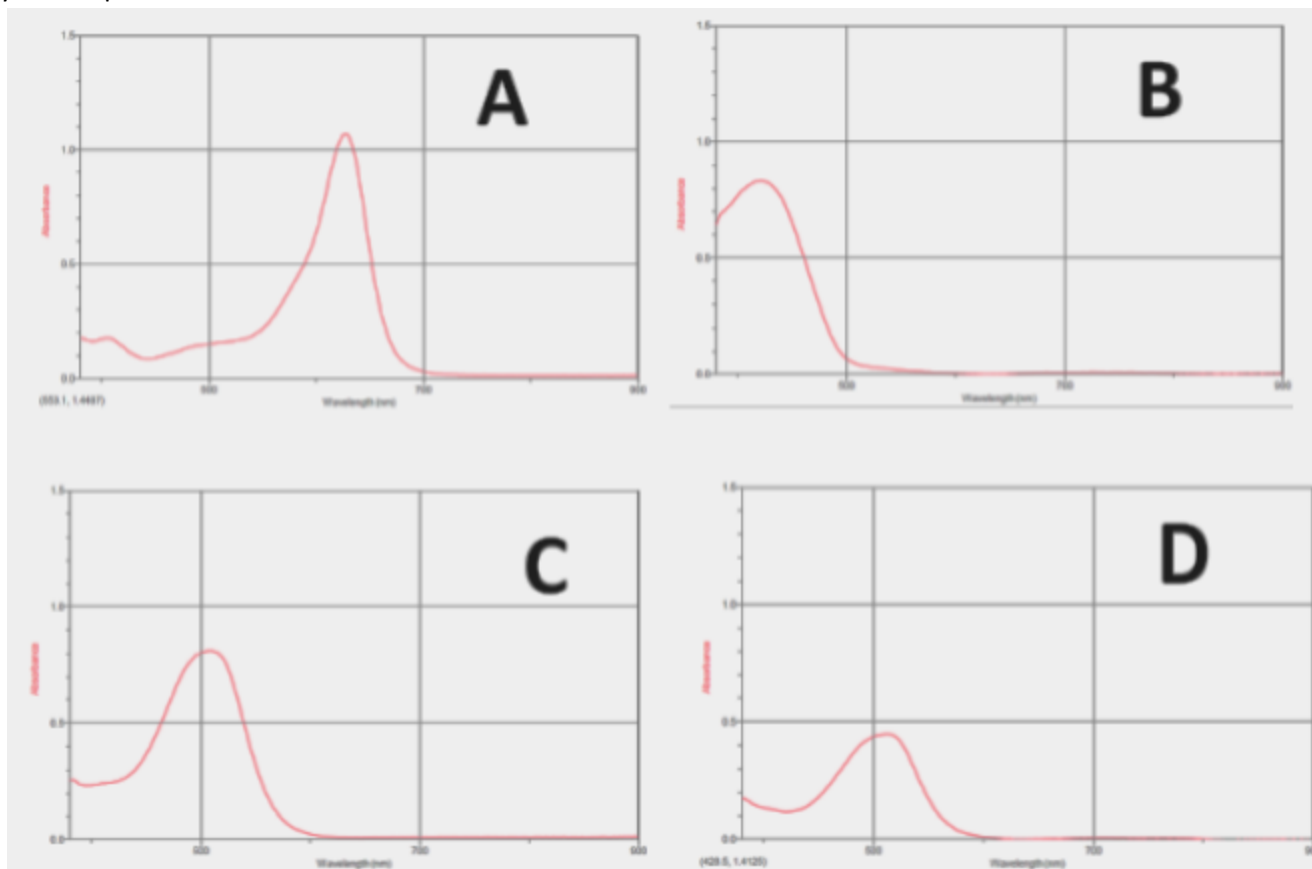


Image: Heather Vernon

It is possible that any of the spectra above are of the same molecule? Support your answer with evidence from the spectra.

| | | | |
|------------------|--|--|--|
| Materials | <ul style="list-style-type: none"> ● Solvent (1:1 Isopropyl Alcohol: Water) ● computer with Logger Pro3 ● Waste container | <ul style="list-style-type: none"> ● 5 cuvettes ● SpectroVis | <ul style="list-style-type: none"> ● 4 paper towel strips ● 4 pens to sample |
|------------------|--|--|--|

Procedure

1. Open Logger Pro on your laptop and connect the SpectroVis.
2. Calibrate the SpectroVis using a blank cuvette filled $\frac{3}{4}$ ths full with the 1:1 isopropyl alcohol/water solution. Place the cuvette into the SpectroVis according to the diagram.
3. On Logger Pro, select **Experiment**, select **Calibrate**, select **Spectrometer 1**. Allow the lamp to heat up, then select **Finish Calibration**, then click **OK**. *You only calibrate the machine the first time you use it OR if you change the solvent.*
4. At the end of the paper towel strip use one pen to draw and color in a box ~ 2 cm by 2 cm. Make sure to label the pen you used on the strip at the other end of the paper towel using Table 1. Repeat this step for each of the pens you are testing. Make sure that only one pen ink is on each paper towel.
5. Roll one paper towel and place it into a cuvette. The side with the pen sample should be at the bottom of the cuvette. Use a pipet to slowly add your 1:1 isopropyl alcohol:water solution to the cuvette. Some of the ink should travel into the solvent. Feel free to “dunk” the paper towel a few times to make sure that your ink is inside the cuvette. The cuvette should end up being $\frac{3}{4}$ ths full.

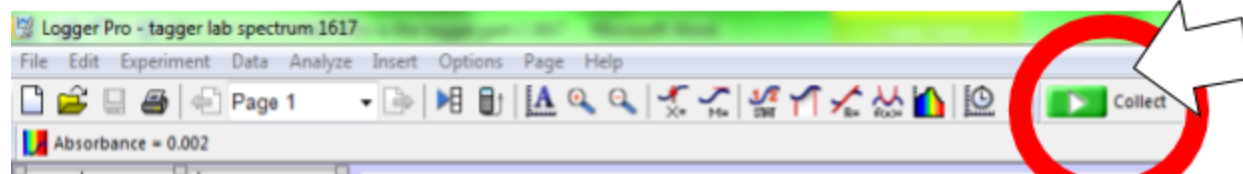


Image: <http://www.vernier.com/products/sensors/spectrometers/visible-range/svis-pl/>
edited by Heather Vernon

| Table 1 |
|-----------------|
| A. BIC |
| B. CaseMate |
| C. PaperMate |
| D. Center Stage |

*****Please note that your solution in the cuvette does not have to be very dark, but you should be able to see that it has ink in it.*****

- When you are done, pull the paper towel out of the cuvette and place in the waste container.
6. Place a lid on top of the cuvette and label it with a sample letter. Repeat this for all of your samples.
 7. To start taking readings, place the first cuvette into the SpectroVis. Click on the **Green Collect** button on the top, right hand corner. (see picture) This will tell the SpectroVis to start recording your data. You should see a complete spectrum.



Logger Pro software image by vernier.com, annotations by Heather Vernon

8. When you are done, click on the **Red Stop button**. This will stop the computer reading your sample. At the left of the data table, if you double click the header, you can edit it to show the sample letter and name you ran.
9. Repeat steps 8-9 for each sample. Select **“Store last run.”** This allows you to have all of the spectra on the same graph. Make sure to go back and enter the sample letter Keep track of which cuvette has which sample.

Explain

Record the spectra for each of your samples below. Make sure to color code and label which spectra belongs to which sample.

Data

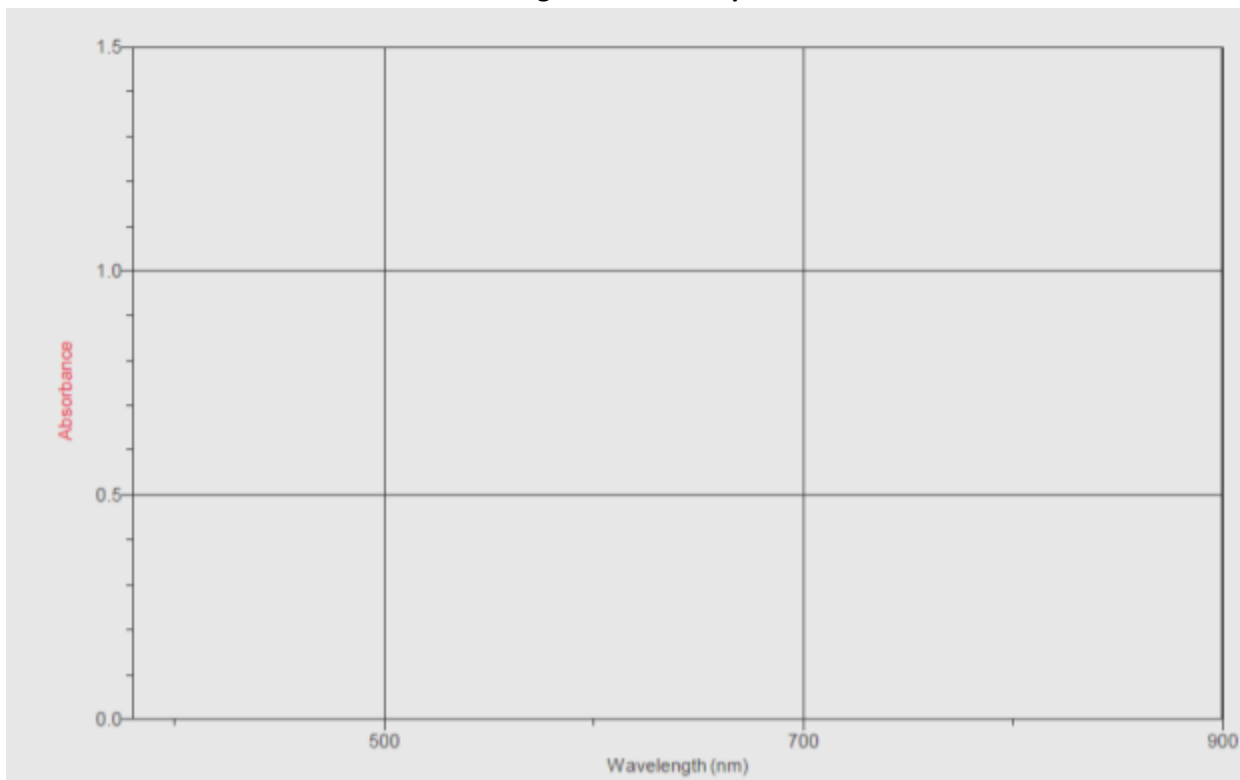


Image: Printout from Logger Pro software, vernier.com

Record at least 4 observations from the graph.

Elaborate

Collaborate with other groups. How do their results compare to yours? Record at least 2 similarities and 2 differences.

Repeatability is critical in science. In this case, your results will be used as evidence to justify a referral for the student from the teacher, to justify an arrest by the School Resource Officer, and potentially in court case if the Whittier Police Department takes the student to trial. How confident are you in the repeatability of your data?

You have created a model scientists call a **standard** to show how the molecules in each of the four types of pens absorb light. While you were doing this, your teacher was able to take a sample of the ink from tagging and run it through the SpectroVis.

Record the spectrum for the Tagger Ink below.

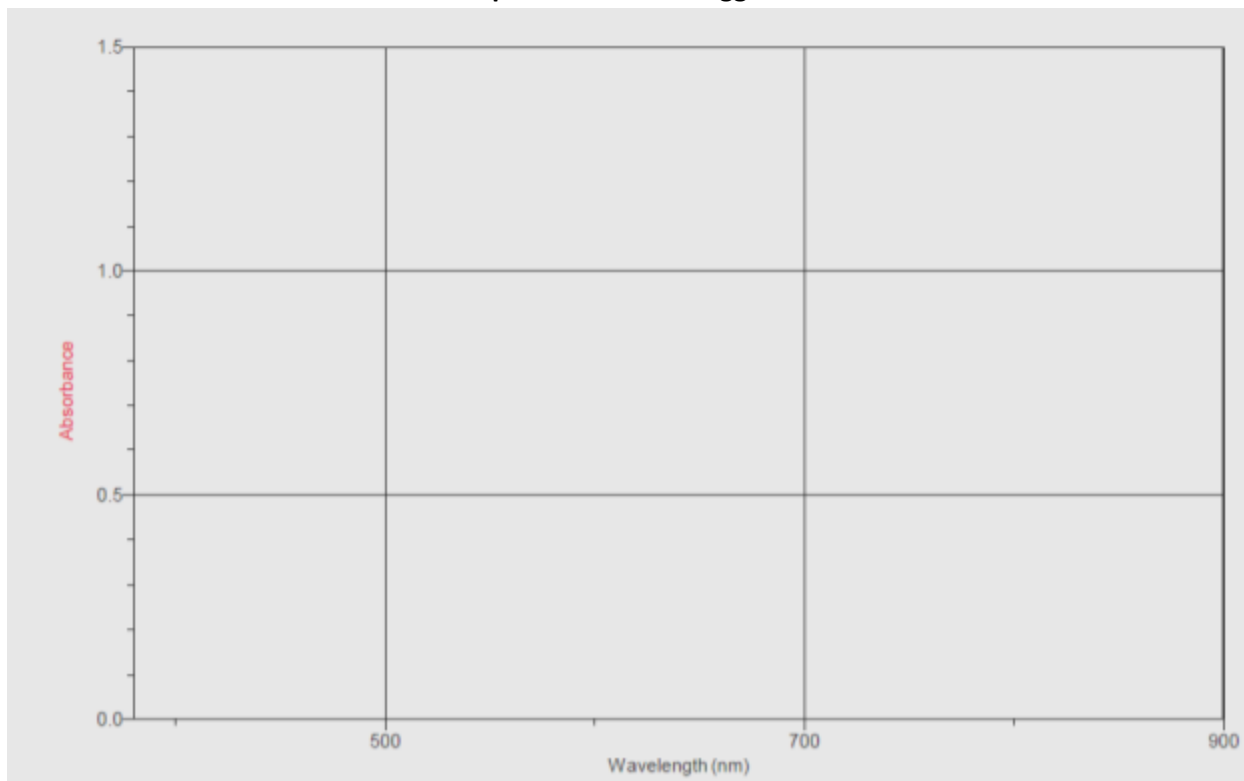


Image: Printout from Logger Pro software, vernier.com

In looking at the spectra of the tagger ink and comparing it to the standards you made, which pen tagged the desk? Cite the data from your standards and the tagger spectra in your answer.

Collaborate with a classmate NOT in your group regarding the results for the lab.
How sure are you that this pen is the tagger? Give a % and explain why you chose this %.

Evaluate & Extend

Conclusion

The Dean of Discipline and the Student Resource Officer (SRO) have been eagerly awaiting the results of your lab to know who to hold responsible for the tagging in the room. Based off of your work today, you have two choices:

- If you are sure of the identity of the tagger, then **write a referral to the Dean of Discipline identifying your claim of who tagged the desk. Cite evidence from both days of lab and explain how the evidence supports your claim of the identity of the tagger.** Consequences for tagging can include being suspended from class, getting a ticket and a court date from the SRO, having to pay for damages, and/or being placed on probation.
- If you are not sure of the identity of the tagger, then **write an email to the Dean stating your claim that the identity of the tagger cannot be determined. Cite the evidence from both days of lab. Explain how the evidence supports your claim that the identity cannot be determined.**

GUIDANCE OFFICE

YOUR HIGH SCHOOL

DISCIPLINE REFERRAL FORM

Student's Name _____ Stu # _____ Grade _____ Period _____ Time _____

STAFF MEMBER MAKING REFERRAL: _____

REASON FOR REFERRAL: (Please check if the appropriate and include description)

- | | |
|--|--|
| <input type="checkbox"/> Defiant Behavior | <input type="checkbox"/> Profanity |
| <input type="checkbox"/> Dress Code Violation | <input type="checkbox"/> Vandalism/Destruction of Property |
| <input type="checkbox"/> Explosive Devices | <input type="checkbox"/> Verbal altercation |
| <input type="checkbox"/> Extortion/Robbery/Stealing | <input type="checkbox"/> Cheating |
| <input type="checkbox"/> Fighting/Assault | <input type="checkbox"/> Drop for tardies |
| <input type="checkbox"/> Left campus without permission | <input type="checkbox"/> Excessive Talking |
| <input type="checkbox"/> Left class without permission | <input type="checkbox"/> Failure to return notice |
| <input type="checkbox"/> Possession of dangerous object | <input type="checkbox"/> Inappropriate Behavior with sub |
| <input type="checkbox"/> Possession/use of drugs/alcohol | <input type="checkbox"/> Not follow directions |
| | <input type="checkbox"/> Throwing objects |

Summary of Teacher's Efforts to Solve Problem:

- | | |
|--|--|
| <input type="checkbox"/> Private conference with student | <input type="checkbox"/> Parent/teacher conference |
| <input type="checkbox"/> Telephone call to parent | <input type="checkbox"/> Progress report |
| | <input type="checkbox"/> Other: _____ |

DESCRIPTION OF SITUATION:

At the end of class, tagging was observed on the lab bench. The pens for all 4 students sitting at the lab bench were confiscated. Previous experiments to determine the identity of the tagger included using paper chromatography to compare results of the four pens confiscated to the ink left on the lab bench. At that time the identity of the tagger

_____ because _____.

Additional laboratory testing used a spectrophotometer to determine the spectra for each of the four confiscated pens and the ink used by the tagger. After comparing the results, the ink from pen _____ is consistent with the ink from the tagger. The evidence supports this claim because _____

ACTION TAKEN (by admin):

Counselor: _____

Who is the Tagger? additional results - Message (HTML)

FILE MESSAGE INSERT OPTIONS FORMAT TEXT REVIEW ADOBE PDF

To... dean of discipline

Cc...

Subject Who is the Tagger? additional results

Send

Dear Dean of Discipline,

At the end of class, tagging was observed on the lab bench. The pens for all 4 students sitting at the lab bench were confiscated. Previous experiments to determine the identity of the tagger included using paper chromatography to compare results of the four pens confiscated to the ink left on the lab bench. At that time the identity of the tagger was _____ because, _____

Additional laboratory testing used a spectrophotometer to determine the spectra for each of the four confiscated pens and the ink used by the tagger. After comparing the results, it was determined that none of the four pens confiscated are consistent with the tagger ink. The evidence supports this claim because _____

Sincerely,
