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CSI: Chemistry Lessons

1. Initial exploration of crime scene

- a. Students are presented with a police report
 - i. Students see video from witness.
 1. Are witnesses always reliable? Why or why not?
 - ii. Discuss difference between fact and inference
 1. Ask students to give examples from the crime circumstances
 2. Are inferences always bad (no, we use inferences every day: my food wasn't poison yesterday, probably okay to eat. Sometimes they can throw us off).
 - iii. Students are *deputized* into the [school name] Bureau of Investigations. They promise:
 1. To be fair and truthful
 2. Not to tell kids in other classes what they discovered that day
 3. To remember that this is a game, and not to bug their teachers too much
- b. Students look at crime scene
 - i. Students sketch crime scene
 - ii. Tag evidence

Items present at crime scene

- Taped outline of body
- Footprints -- 27.5 in. apart, heel to heel
- Note in black ink: "[victim's first name]-- Can you meet me in the science lab? I need help cleaning the 3D printer"
- HCl -- spilled bottle
- Fibers found around body
 - Some also under
- Bleach container
- Caution tape
- Metal items

2. Chromatography

- a. Do now: Read chromatography lab
- b. Students see video from “metallurgist” [art teacher] about piece of metal found at scene -- says it was from an art project made for advisors
 - i. Does finding who owns the bracelet mean we know who did it (no, but it gives us a direction to go in)?
- c. Students are presented with a teacher sign in sheet from the morning.
- d. Explain chromatography
 - i. What is the difference between a mixture and a chemical reaction?
 1. Food coloring example -- take a beaker of water, add a drop of red and drop of blue food coloring. Ask: Did a chemical reaction happen? What defines a chemical reaction (new molecules). Students should come up with these possibilities:
 - a. No: molecules of different food coloring just mix together.
 - b. Yes: made new purple molecules
 2. Leave the question unanswered. Ask: how could we demonstrate it is a mixture? (if we could separate them back out)
 3. Answer chromatography check for understanding questions.
- e. Students complete lab
- f. Homework: finish questions

Teacher setup Chromatography lab

1. Materials
 - a. Filter paper
 - b. Sharpie
 - c. Crayola marker
 - d. Small beakers
 - e. Cups to group strips
 - f. Rubbing alcohol
2. Cut filter paper into strips
3. For known and matching strips, use a crayola marker. For not matching, use a sharpie
4. Make a set of “known” strips that represent the note, 1 per lab group for all 3 sections (15 total). Make a dot about 1 cm from the bottom of the paper with the crayola marker.
5. Create enough “matching” strips for the main suspects PLUS 3-4 more, again all 3 sections (don’t need 1 per group)
6. Create “not matching strips” for everyone else, again all 3 sections (don’t need 1 per group)
7. Write the initials of the main suspects + 3-4 teachers who do teach when the murder happened, each on their own “matching” strip. You will need 3 sets.

8. Write the initials of the remaining advisors on the other strips, again you will need 3 sets.
9. Mix the matching and not matching. Divide all the strips into 5 groups. Add a “known” strip to each group. Do this for each of the 3 sets.

3. Time of death

- a. Review chromatography lab questions
- b. Students see autopsy video
- c. Using their “time of death” graphs from the “Time of the crime” lab, students calculate time of death based on temperature and determine when person died. They figure out she died at 2:30.
- d. Students are given teacher schedules and further narrow down a list of suspects. Teachers who had a class at 2:30 are eliminated
- e. Homework: Reading: What is a chemical reaction?

4. Students come up with questions to interview suspects

- a. Review chemical reactions check-in quiz and/or reading, give students their study sheet for test next week
- b. Do elephant toothpaste demo
- c. Students are given time to come up with interview questions and/or study
- d. Questions that will actually be used:
 - i. What was your relationship with the deceased?
 - ii. Do you still have the bracelet [art teacher] made you?
 - iii. Were you in the lab that day?
 - iv. What were you wearing the day of the crime?
 - v. What is your height?

5. **Graphing stride vs. height** (will probably need to combine this with watching/analyzing suspect video and make it into two lessons)

First half:

- a. Students read article linked in The Height of the Killer
- b. Ask: What does correlation mean?
- c. Read step 2-4 in the lab
- d. Students come up with a way to measure their stride length and correlate it to their height

Second half: record data. Share a spreadsheet with the entire grade, and have them all add their data to the spreadsheet.

Teacher setup:

1. Mark out distances in three places in the lab. Go up to 5 m in each place
2. Students can just measure their last step from the nearest marked spot
3. Procedure should look something like this:
 - i. Take 5 steps
 - ii. Measure total distance walked
 - iii. Divide by 5
4. Create shared spreadsheet for entire class's data
5. Materials:
 - i. **Painter's tape** for marking distances
 - ii. Meter sticks

6. Graphing stride vs. height

- a. Students create a scatterplot and trendline
- b. Students discuss reasonable margin of error
- c. Students find out killer's stride
- d. Killer's approximate height is found by correlating the stride to the height
- e. Students watch suspect videos

Teacher setup

- a. Make a copy of the class data sheet
- b. Share the copy through doctopus
- c. Make a sample graph
- d. Decide the height of the killer. Make it a height that is near to a bunch of suspects (for example, if suspects heights are 5'2", 5'3", 5'4", 5'11", 5'10", make the height of the killer 5'3")
- e. Use the killer's height to decide the stride of the footprints at the crime scene

7. Cause of death: Bleach and ammonia

First half:

- a. Have a student come up and write down the suspects we have left after looking at the teaching the class "alibi". Other students should help.
- b. Project the height vs. stride graph. Have a student show how we found the approximate height of the killer
- c. Read as a class the end of the The Height of the Killer
- d. Say "Given what we just read which suspects can we eliminate?". Call up a student to cross names off. Have that student call on other students to nominate

suspects to be eliminated and to give a reason why. Suspects should only be eliminated based on height, not other factors like "sounding guilty"

Second half:

- e. Students complete Cause of Death activity
 - i. Students use atom models to discover the cause of death: chlorine gas

8. Density

Note-- this was a bit rushed, but I needed to condense it into one lesson due to timing.

- a. Have a student read the Forensic lab report
 - i. Ask -- We normally think of an email as private. Who do we need permission from to read someone's email (a judge)? Why do you think that is?
 - ii. Have a student read the first email
 - iii. Have another student read the second email
 - iv. Suggest that we are starting to see a motive.
- b. Have students open the lab and read it over
- c. Go over check for understanding questions
 - i. Give students data:
 - 1. Substance found on victim's neck -- density = 0.95 g/mL
 - 2. [suspect #1]-- Wax
 - 3. [suspect #2] -- Crayon
 - 4. [suspect #3] -- Play doh
- d. Do class demo to find final densities

Teacher setup

- 1. Materials
 - a. Black Play doh
 - b. Black crayons, ends cut off
 - c. Black wax blocks
 - d. Rulers
 - e. Scales
- 2. Materials for class demo
 - a. Fill graduated cylinder with water and oil
 - b. Write on the board density of water (1.00) and oil (0.90)
 - c. Prompt:
 - i. If something floats, what do we know about its density (<0.9)?
 - ii. What are we looking for? (should end up in the middle)
 - d. Drop in a small sample of each substance. Play doh should sink, wax float, crayon end up in the middle.

9. Presentations

- a. Start class with the first slide of “The Trial” projected on the board.
- b. Explain to class that we will have a trial, and that they will be the prosecution.
Each group will be in charge of one aspect of the case
- c. Divide class into groups. Give each group a part of the case to present
- d. Give groups 15 minutes to prepare
- e. Have each group present.
- f. If time, you can show them a brainpop:
 - i. <https://www.brainpop.com/socialstudies/usgovernment/courtsystem/>

10. Wrap-up

- a. Show confession video
- b. Have fishbowl discussion about “lawyering up”
- c. Show students brainpop about [Miranda Rights](#)
- d. Continue with presentation. Show first 2 minutes of [Alan’s story](#),
- e. Explain to students that while most of the time people convicted are guilty, sometimes there are mistakes. The innocence project is a group that tries to find wrongfully convicted people and free them. We will now hear from Alan’s lawyer for the innocence project.
- f. Show just lawyer’s speech at 5 minutes
- g. Say that we will now hear from Alan. Ask a student to explain what a jury is.
- h. Show last minute with Alan talking.
- i. Finish with quote in presentation. Encourage students to know both their rights and their responsibilities.
 - i. "Public business must always be done by somebody. It will be done by somebody or other. If wise men decline, others will not; if honest men refuse it, others will not."
-John Adams

Past:

11. Fiber analysis

- a. Students burn (ahhh!) various fibers found at the crime scene to identify them
- b. Students discuss the implications of where the fibers were found: those found under the body must have been there at the time of death. Those around the body could have been there after
- c. Some teachers who denied being at the crime scene at all that day are confirmed to have been there

Behind the scenes: Some fibers are found exclusively under the body. The killer has been cleaning up.

'It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts.'

Sherlock Holmes
-*A Scandal in Bohemia*

'You know my method. It is founded upon the observation of trifles.'

Sherlock Holmes Quote
-*The Bascombe Valley Mystery*

'There is nothing more deceptive than an obvious fact.'

Sherlock Holmes Quote
-*The Bascombe Valley Mystery*

'''Is there any point to which you would wish to draw my attention?'

'To the curious incident of the dog in the night-time.'

'The dog did nothing in the night-time.'

'That was the curious incident,' remarked Sherlock Holmes.'''

Exchange between Inspector Gregory & Sherlock Holmes
-*Silver Blaze*

'How often have I said to you that when you have eliminated the impossible, whatever remains, *however improbable*, must be the truth?'

Sherlock Holmes Quote
-*The Sign of Four*

Chapter 6: "Sherlock Holmes Gives a Demonstration"

"Every measurement slowly reveals the workings of the criminal. Careful observation and patience will reveal the truth."

—Alphonse Bertillon, French criminologist

"I have the advantage of knowing your habits, my dear Watson," said he. "When your round is a short one you walk, and when it is a long one you use a hansom. As I perceive that your boots, although used, are by no means dirty, I cannot doubt that you are at present busy enough to justify the hansom."

"Excellent!" I cried.

"Elementary," said he. "It is one of those instances where the reasoner can produce an effect which seems remarkable to his neighbour, because the latter has missed the one little point which is the basis of the deduction. The same may be said, my dear fellow, for the effect of some of these little sketches of

yours, which is entirely meretricious, depending as it does upon your retaining in your own hands some factors in the problem which are never imparted to the reader. Now, at present I am in the position of these same readers, for I hold in this hand several threads of one of the strangest cases which ever perplexed a man's brain, and yet I lack the one or two which are needful to complete my theory. But I'll have them, Watson, I'll have them!" His eyes kindled and a slight flush sprang into his thin cheeks. For an instant the veil had lifted upon his keen, intense nature, but for an instant only. When I glanced again his face had resumed that red-Indian composure which had made so many regard him as a machine rather than a man.

Old lessons:

Lesson 4/5

Electrolysis

Students learn how to test for the presence of H₂ gas through an electrolysis lab.

Suspect interviews

- d. Students investigate metals in HCl (demos)
- e. Some metals match metals found at the crime scene
- f. Students review suspect interviews
- g. Some suspects admit to having been in the lab that day, others deny it

Cleaning log shows lab was cleaned over the weekend

Notes:

- Someone is going to figure it out the first day “wait a second, bleach + ammonia is poisonous”. Just let it happen
- Kids are going to get upset and say things like “just b/c they used that pen doesn’t mean they did it” or “what if they borrowed a pen”. Emphasize that suspects aren’t people we think did it and want to arrest, they are people we want to talk to more. Also, for example, they’ll say that the metal bracelet could belong to anyone, or to Ms. S. Suggest that it gives us a direction to go in. That direction might be wrong, but at least it is a start.
 - Don’t rely on yourself to justify every missing piece, kick out to the students “ok, so it might not be their bracelet, why might we want to check it out anyways...any ideas”
- I feel so awkward doing this, you just got to go with it
- Teachers love participating
- If students persevere on a “hole” in the case, you can always introduce new evidence: the teacher was checked out of the building, called to the office, etc.
- They are going to be claiming conspiracy every step of the way. Say “let’s base our thoughts on fact, not inference”. Then just let them say it and ignore it. You won’t win the pissing match
- For videos, be ambiguous about date -- then can reuse year to year