Lesson title: Developing fingerprints using cyanoacrylate fuming

Course/subject: Criminal Investigations

Grade level: 10-12

TEKS standards covered: 125.115(c) 2A, 2C, 2E, 3I, 4A, 4C, 5B

Applicable TAKS objectives: ELA Objectives 4, 5, 6; Science Objective 1

Content/subjects covered prior to this lesson: History of fingerprinting, Types of fingerprints, Fingerprint patterns and characteristics, dusting & lifting latent prints, lab safety

Technology tools needed: Beakers, gloves, goggles, test tube rack, and acetone

Special equipment or materials needed:

Teacher demonstration: fish tank, rubber cement, superglue, a sheet of aluminum foil long enough to cover all but about 10cm of the inside of the tank, a single coffee cup warmer, coke can, bottle cap.

Student experiment: cardboard box, tube of superglue (gel version works a little better), light assembly coke can, and dusting powder.

Applicable websites/internet resources: www.fbi.gov/hq/lab/handbook/, www.crimeandclues.com

Brief description of lesson plan: Demonstrate and analyze the technique used for visualizing latent fingerprints on nonporous surfaces by exposing them to cyanoacrylate vapors.

I. Engagement: The activities in this section capture the student's attention, stimulate their thinking and help them access prior knowledge.

- The goals of this lesson are to understand the basic scientific concept behind cyanoacrylate fuming; be able to develop latent fingerprints using this method; and evaluate the usefulness of this technique.
- Teacher will explain the three general groups of techniques for making latent fingerprints visible. The three groups consist of the physical techniques (such as dusting), the instrumental technique (lasers), and the chemical techniques. Cyanoacrylate (superglue) fuming is a chemical technique.
- Super glue is a mixture of 98-99% of either methyl, ethyl, or butyl2-cyanacrylate and 1-2% of an inhibitor. Superglue reacts with the traces of amino acids, fatty acids, and proteins in the latent fingerprint and the moisture in the air to produce a visible, sticky white material that forms along the ridges of the fingerprint. The moisture in the air is sufficient to initiate polymerization once a drop of glue is placed. This produces a few long and very short polymer chains. The final result is an image of the entire latent fingerprint.
- Students will be given the following case scenario to set up the activity:
  Mrs. Morriss has noticed that several cokes have been missing out of her refrigerator on a daily basis. One day, after 2nd period, Mrs. Morriss noticed 5 empty coke cans under her desk. Your job
is to use cyanoacrylate fuming to determine if there are any possible prints on this can that do not match Mrs. Morriss’. We will later compare the prints to all the student fingerprint cards (taken in a previous lesson) to identify the thirsty culprit.

- **Steps-Teacher demonstration:**
  1. Remove any objects from the inside of the fish tank. Wipe off all the walls with a cloth dampened with acetone.
  2. Place the aluminum foil around the inside of the fish tank so that a small opening is located so you can see your object when it is placed on the rack.
  3. Place a small amount of rubber cement along the top of the fish tank to hold the foil in place. Over a period of time, the walls will become coated with Super-glue polymer, eventually making direct observation impossible.
  4. Place the coffee cup warmer inside the fish tank and off to one side.
  5. Place the wire rack inside the fish tank.
  6. The object will be an empty can of soda. Teacher will put on plastic gloves on one hand, handle the can, and place it on the rack. Remove the glove (leave it inside out) and place it next to the soda can.
  7. Place a small bottle cap on the warmer and then add 10-12 drops of superglue.
  8. Place a small beaker of water in the chamber.
  9. Place the cover on the chamber and turn on the heater. Watch the soda can where you know there is a print as well as the fingertips of the glove. It will usually take about 5 minutes before a visible print is obtained.
  10. Turn off the heater and remove the can (wear gloves). Write down observations on data sheet.
  11. Then remove the glove and write down observations on data sheet.

- **Steps-Student exercises:**
  1. Students will need a cardboard box, a tube of superglue, a light fixture assembly and a can of soda.
  2. Set your coffee cup warmer or light bulb assembly in one corner of the box.
  3. Make a small dish from a single layer of aluminum foil and place on top light bulb assembly.
  5. Place a cup of hot water inside the chamber to add humidity to the air.
  6. Stand up evidence. Lean can in the corner of the chamber.
  7. Close chamber, and turn bulb on for at least 10-15 minutes.
  8. Dust print with fluorescent powder.

- Students will work in groups of 3-4. Activity will be conducted in a well-ventilated area, outside of the classroom.
- I use open-ended questions that promote thinking and student involvement. Often, I will ask some students to comment on the answers given by others.

**II. Exploration:** In this section students are given time to think, plan, investigate, and organize collected information.
• Problem solving will occur in small groups with 3-4 students. They will need to recreate the superglue demonstration using different materials. For example, instead of using a fish tank and a coffee cup warmer, they will be using a cardboard box and a 60-watt light bulb.

• Sample questions that might be expected from students and possible teacher responses

1. Are the fumes toxic? At high concentrations it may make your nose burn and tears may form. It’s recommended to have a chamber with an exhaust system of some type.

2. Can you use a hot plate or open flame as your heating element? Use should use a coffee cup warmer or light bulb. The red-hot coils of a hot plate can cause a flash fire from the volatile superglue fumes, and the high temperature can produce poisonous gases.

3. What other things might work for a fuming chamber? You can use a garbage can turned upside down, an old briefcase, a filing cabinet, with the drawers removed and a plastic bag taped over the front, etc.

• Stumbling blocks students might encounter

1. The latent fingerprints may be underdeveloped which indicates that an insufficient amount of superglue was added. Teacher may ask for thoughts on why a fingerprint may not fully form.

2. If the process runs unchecked, the latent fingerprints can overdevelop and the chemical images of the ridges will slowly grow wider until they overlap, obscuring vital detail. Teacher can encourage higher level thinking with questions such as “What are the possible consequences of inadequate monitoring?”

• Key points to remember

1. In order for a reaction to take place, the cyanoacrylate must be in its gaseous form.

2. The boiling point for most super glue varies between forty-nine and sixty-five degrees Celsius (roughly one-hundred twenty to one-hundred fifty degrees Fahrenheit) depending upon its exact chemical composition.

3. Do not let the light bulb touch the walls of your cardboard chamber or your evidence, otherwise, you may start a fire!

4. Once the super glue in the container reaches its boiling point, it will begin to boil away into the surrounding atmosphere, creating a concentration of gaseous cyanoacrylate. If any latent fingerprints exist anywhere inside the tank, they will eventually be exposed to the gaseous cyanoacrylate. This exposure and the natural humidity contained in the atmosphere are enough to trigger the reaction automatically.
III. **Explanation:** Students are now involved in an analysis of their exploration. Their understanding is clarified and modified through group discussion and reflective activities.

- **Class Discussion**

There are several methods investigators use to develop a latent print with Superglue.

The water vapor method, which was used in this lesson, is extremely simple in theory and in practice. Since the reaction requires moisture from the air to occur, the air in the tank can be kept at a high level of humidity to ensure that there will always be enough moisture for the reaction to take place. The humidity in the tank can be kept high simply by placing an open container of water inside the tank.

Another method commonly used is chemical acceleration whereby the heater is discarded and a chemical is placed in contact with the super glue. For example, a cotton ball is soaked in 0.5m NaOH solution and dried. The cotton ball is placed in the fuming chamber and when a few drops of Superglue is added, fumes will form in a few seconds. This method can be used to examine large areas such as the inside of a car.

A handheld fuming wand is a fairly new technology that investigators can use at the crime scene and in the laboratory. The wand is designed to heat a small cartridge containing a mix of cyanoacrylate and a fluorescent dye. Once heated, the cyanoacrylate and dye mix will vaporize, and the investigator can direct the fumes onto the suspect area.

- **Possible student questions and reactions**

  What other surfaces does superglue work on? Glass, metal, plastic, leather, and electrical tape.

  What surfaces will cyanoacrylate fuming not work on? Superglue does not work as well on non-porous surfaces such as paper or unfinished wood, and wet surfaces.

  Will fuming destroy any DNA? Yes, it can. An item should be examined for blood, saliva fibers hairs, etc. before fuming.

  What are some problems with Superglue fuming? Fingerprints developed with Superglue are hard to remove. Using a mild abrasive and rubbing can ruin the surface. Be sure not to fingerprint an object that may be used again unless you are fairly certain that it contains a print. If you fingerprint the inside of the car, the residue is probably there to stay.

  Why does the reaction take longer in different fuming chambers? The whole reaction can take over two hours, with the exact time determined by the size of the tank, the concentration of the gaseous cyanoacrylate in the air, the humidity of the air, and numerous other factors.

- **Main points**

Superglue fuming has become a very useful technique for investigators. Three elements are necessary inside the chamber: superglue fumes, humidity and warmth.
The white appearance of the fingerprint is thought to arise when salt crystals form minute droplets of salt-water solution at higher humidities. The salt water appears to initiate the growth of cyanoacrylate polymer fibres.

**IV. Extension:** This section gives students the opportunity to expand and solidify their understanding of the concept and/or apply it to a real world situation.

- Superglue fuming has also been proven successful when retrieving latent prints from a homicide victim. Using a portable fuming chamber or a fuming wand, investigators are able to obtain usable prints from the skin of the deceased.

- When fingerprints are lifted from a crime scene, they may not be in perfect condition. With the help of digital imaging software, fingerprints can now be enhanced for the most accurate and comprehensive analysis. For instance, a print that is too dark can be processed with an equalization filter, exposing more of the fingerprint characteristics.

- Upon completion of the lab, the groups will examine all student fingerprint cards and compare them with the developed print. They will be able to classify the prints by pattern types, by the size of those patterns, and by the position of the patterns on the fingerprint. Using fingerprint magnifiers, they should be able to name the coke-drinking thief.

- As an extension exercise, students will research the FBI’s Integrated Automated Fingerprint Identification system (IAFIS). They should report on history, method, database, and major services available to local, state, and federal law enforcement agencies. Finally, students will research the admissibility of fingerprints in court. They will need to include the court standard and relevant court rulings.

**V. Evaluation**

- Tools used to measure student success:
  - Teacher observations
  - Performance-based assessment for the lab activity (using rubric)
  - Student peer evaluations and self-evaluations
  - Oral and Written presentation rubric for extension activity
  - Test covering fingerprint evidence, including history, types, patterns, developing methods, AFIS, and court rulings.

- Reflection
  - Assignment notebooks-includes reflective journal assignments, class notes, graded tests and papers, etc.
  - Students will be able to share any ideas or experiences through class and group discussions