Glass Lab

Background: Often, forensic scientists need to determine the characteristics of items found at a crime scene and compare these items to ones found on a suspect or at the suspect's home or car or boat or other things connected to the suspect. Physical Properties of these trace substances can be used to describe and compare the items of interest.

The Locard Principle states that if one surface touches another, there will be an exchange of some physical material, which can be identified. Physical properties that describe substances can include: weight, volume, color, boiling or melting points, density and refractive indices. Glass can be characterized by these characteristics.

The density or specific gravity of glass can be determined by obtaining the mass by weighing it on a balance and dividing by the volume determined by the water displacement method or by the Archimedes principle, "Criminalistics" Lab Manual, (Meloan and Sapustein). The Densities of different glass samples can be compared and used to determine if there is a match between glass connected to a suspect and glass found at the crime scene.

Another physical property that can be used to compare glass samples is the refractive index. In general, different glasses and different liquids have specific refractive indices. If a glass sample is put into liquids of the same refractive index, it will not be visible as in the demonstration described below. If the refractive indices are different a dark edge or boundary can be seen with the naked eye and under a microscope. This line or edge is called the Becke line. If the line is not seen, the refractive index of the glass and the liquid are the same. Thus, the forensic scientist has another physical characteristic to analyze in order to I.D. a glass sample and connect a crime scene to a suspect.

Fundamental Understanding:

- Different types of glass have different densities
- Different types of glass have different refractive indexes

Essential Question

What characteristics of glass can be used to identify different types of glass?

Purpose: To determine different characteristics of glass in order to be able to match glass from a crime scene to a suspect.

Activity 1 Density of Glass by water displacement:

Procedure:

1. Weigh the piece of glass. _____ g. (approx. 1-2 cm^2 x 2-3 mm)
2. Place 50.0 ml of water into a 100 ml graduated cylinder and gently place the piece of glass into the graduated cylinder and record the new volume. _____ml.
3. Subtract 50.0 ml from the new volume _____ml to get volume of glass.
4. Divide the mass of the glass by the difference in volume (step 3) and obtain the density of the glass in g/ml.

Activity 2: Density of Glass using Archimedes principle:

Background: "Archimedes's principle states that an object immersed in a fluid displaces a volume of liquid equal to its volume" e.g. a 1 cm^3 of glass weighs about 2.5 g while a 1 cm^3 of water weighs 1.0 g, when the glass cube is placed in water it will weigh 2.5 g minus 1.0 g or it will weigh 1.5 g., which gives the volume of the glass to be 1.5 cm^3."Density of Glass" lab using Archimedes principle ("Criminalistics" Lab Manual by Clifton E. Meloan, Richard E. James and Richard Saperstein, seventh edition p. 13.)

Materials:

1. Microscopes
2. Cover slips
3. Kim wipes
4. microscope slides
5. glass stir rods
6. forceps
7. Mortar and pestle, to grind glass
8. **glass from different sources** e.g.
9. *car headlights 1.47-1.49*
10. *TV 1.49-1.51*
11. *window glass 1.51-1.52*
12. **liquids of different refractive indices**
13. *methyl alcohol 1.3288 (Scientific Supply)*
14. *water 1.330*
15. *olive oil 1.4667 (grocery store)*
16. *castor oil 1.4820 (drug store)*
17. *clove oil 1.5430 (drug store)*
18. *liquid 1.480 (Cargille labs)*
19. *liquid 1.500 (Cargille labs)*
20. *liquid 1.510 (Cargille labs)*
21. *liquid 1.530 (Cargille labs)*

Procedure: Using different colors and sizes of glass approximately 1 cm square by 0.2 cm thick, the density was determined by the following method:

1. Weigh the piece of glass and record value_____g.
2. Weigh a beaker with approximately 200ml of water. Record value ____ g
3. Tie a thin string, ribbon or strong thread around the glass and suspend in the beaker of water (a ring stand with ring works well). Do not let the glass touch the sides or bottom of the beaker. Record the change in mass:____g. This increase in mass in grams is converted to volume using the relationship of 1.0 g = 1.0 cm^3 for water.
4. Divide the mass of the glass by the volume (step 3) obtaining the density of the glass in g/ml.

Activity 3: Refractive Index of Glass Fragments

("Density of Glass Fragments" Lab Manual by Clifton E. Meloan, Richard E. James and Richard Saperstein, seventh edition p. 31.) Many of the materials used in this lab were obtained from R. P. Cargille Laboratories; others were purchased at a grocery or drug store. In this lab different types of glass and refraction oils (both from Cargille labs) can be compared under the microscope by observing the different glass in different refraction oils. Thus, forensic scientists can further identify the glass, connecting the glass to a suspect.

Procedure:

1. Clean slides with soapy water and rinse well with distilled water followed by an alcohol rinse (70% isopropanol works well). Then dry with Kim wipe or lens paper. Label appropriately with the liquid and the glass type or index.
2. Sodium chloride crystals can be compared in the above refractive liquids with a clear Becke line. Sodium chloride is regular in shape while the glass fragments look like boulders (i.e. irregular shapes) under the microscope.
3. Label slides with glass and liquid refractive indices before placing liquids or glass on slides.
4. Using clean forceps, place a very small amount (as little as possible) of glass fragment onto the labeled slide.
5. Add the refractive liquid of choice and mix gently with glass rod. Be careful not to cross contaminate glass or liquids, keep all separated.
6. Compare as many combinations of glass types and refractive liquids as possible, looking for the Becke line. The larger the differences between the refractive indices of the glass and the liquid, the darker and clearer the Becke line.
7. Determine the refractive index range (closest to which liquids i.e. lightest Becke line) of the glass sample.
8. By comparing different glass samples, a match of known glass to the glass found at the crime scene can be determined.

Questions and Conclusion:

1. How would you use refractive liquids to identify difficult types of glass?
2. What is the Becke line?
3. What shape are the sodium chloride crystals in a refractive liquid?
4. What shapes are the glass fragments?