EXAMINING GLASS EVIDENCE: Student Notes

Properties of Glass

Altering the compounds used to make glass changes the composition and produces different types of glass. Because of this, it is possible to distinguish one type of glass from another by examining different physical and chemical properties.

1. Density

Each type of glass has a density that is _____ to that glass. One method of matching glass fragments is by a density comparison.

- Density formula:

- using the mass obtained, and _____ _____ for volume of glass, you can determine the density of a glass fragment and compare it to a series of known density values.

2. Refractive Index

When a beam of light moves from one medium (air) to another (water), its _____ changes.

This change in speed causes the beam to change direction, or _____.

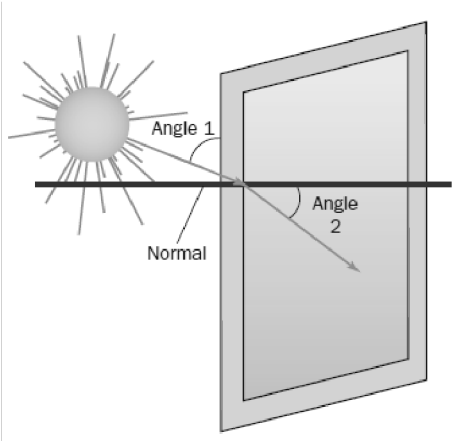
- Refraction is the change in the _____ of light as it speeds up or slows down when moving from one medium to another.

The refractive index is a tool used to study how light bends as it passes through one substance and into another

The refractive index is calculated by dividing the speed of light in a vacuum by the speed of light through that particular substance

- Light in a vacuum travels at _____

If light travels from a less-dense medium to a denser medium, the beam of light will slow down and bend toward the normal, as shown below.



The normal is a line perpendicular to the surface where the two different mediums meet. The incoming beam of light passing through the first medium is called the _____ ray, and the beam of light as it passes through the second medium is called the _____ ray.

- The angle the incident ray in medium 1 forms with the normal is called the _____ (labeled to the left as angle 1)

- The angle the refracted ray in medium 2 forms with the normal is called the _____ (labeled to the left as angle 2)

Snell's Law – describes the behavior of light as it travels from one medium into a different medium

Snell's Law **n_1(sine angle 1) = n_2(sine angle 2)**

n_1 = refractive index of medium 1 angle 1 = angle of incidence
n_2 = refractive index of medium 2 angle 2 = angle of refraction

Example 1: A beam of light travels in air (medium 1) and then passes through a piece of glass (medium 2). As the light passes from the air into the piece of glass, the light ray is bent. The refractive index of air (medium 1) is 1.00, the refractive index of glass (medium 2) is 1.50, angle 1 is 45°, so what is the angle of refraction measured from the normal?

Example 2: As light travels from water (medium 1) to air (medium 2), it bends.

refractive index of water (medium 1) = 1.33 angle 1 = 30°
refractive index of air (medium 2) = 1.00 angle 2 = ?

Use Snell's Law to determine the size of angle 2.

Does the light slow down or speed up as it passes from medium 1 through medium 2?

_____ Will the light bend toward the normal or away from the normal?

_____

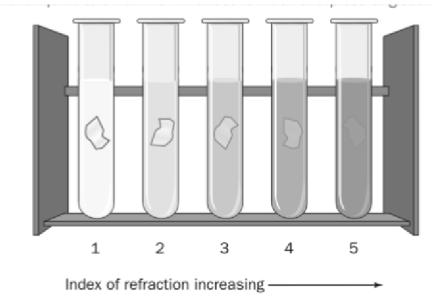
<u>Application of Refractive Index to Forensics</u>
- Match glass from a crime scene to glass collected as evidence

1) Compare the refractive index of the evidence glass to the refractive index of the glass from the crime scene

<u>Submersion Method</u>

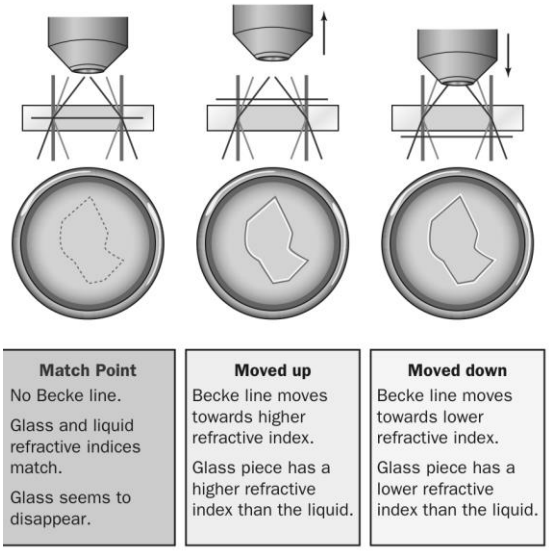
Placing the glass fragment into different _____ of known refractive indexes

If the glass has the same refractive index, the glass fragment will seem to _____ in the liquid



Becke Lines

Submerging the fragment of glass in a liquid and then viewing it under low power using a microscope - if the refractive index of the liquid medium is different from the refractive index of the piece of glass, a _____ ring appears around the edges of the glass – this effect is called a becke line



Match Point	Moved up	Moved down
No Becke line. Glass and liquid refractive indices match. Glass seems to disappear.	Becke line moves towards higher refractive index. Glass piece has a higher refractive index than the liquid.	Becke line moves towards lower refractive index. Glass piece has a lower refractive index than the liquid.

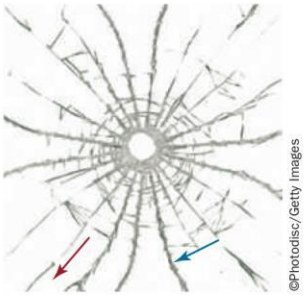
Fracture Patterns

Glass has some flexibility. When glass is hit, it can stretch slightly. However, when the glass is forced to stretch too far, _____ lines appear and the glass may break.

- Glass is an amorphous solid (its atoms are not arranged in a pattern). Therefore, glass will break into _____, not into regular pieces with straight lines at the edges.
- The fracture patterns formed on broken glass can provide clues about the _____ and _____ of impact.
- When glass breaks, fracture patterns form on the surface.
    - The first breaks, called _____ fractures, are produced. These fractures start at the point of impact and radiate, or move outward, from there. Radial fractures form on the side _____ the point of impact.
    - Secondary fractures may also form. These fractures take the form of _____ circles around the point of impact. These are circles that have the same center. Concentric circle fractures form on the _____ side of the glass as the point of impact.
    - By examining these glass fracture patterns, it is possible to determine which side of the glass was hit

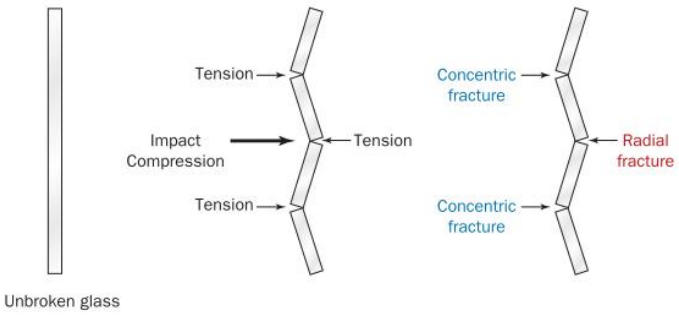
Radial Fractures

Concentric fracture



Why do radial and concentric fractures form?

When an object, such as a bullet or rock, hits glass the glass stretches. On the side where the impact takes place, the glass surface is compressed, or squeezed together. The opposite side of the glass (the side away from the impact) stretches and is under tension. Glass is weaker under tension than under compression. It will break first on the opposite side. After the primary radial fractures form, the concentric fractures form. They are formed on the same side as the impact or force on the glass



If there are several strikes to the glass, the _____ in which the strikes occured can be determined if enough of the glass is available or can be reconstructed.

- The first shot produces the first set of fracture lines. These lines set the boundaries for further fracturing by following shots.
- Radiating fracture lines from a second shot stop at the edge of fracture lines already present in the glass.

Each time glass is struck, it gets weaker and weaker

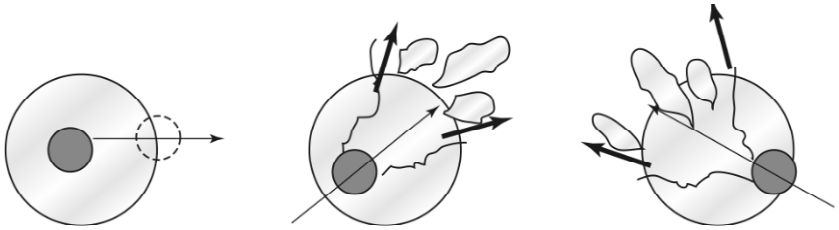
- The number of radial and/or concentric fractures typically will _____ with each strike/impact on the same piece of glass

Bullet Fractures

As the bullet passes through the glass, it pushes some glass ahead of it, causing a _____ shaped piece of glass to exit along with the bullet. This cone of glass makes the exit hole _____ than the entrance hole of the bullet.

Path of a Bullet

- If the bullet was fired perpendicular to the windowpane, the entry hole of the bullet will be _____.
- If the bullet was fired into the window at an angle, fracture patterns in the glass left by the bullet can be used to help locate the shooter's position.
  - If the shooter was firing at an angle coming from the left, glass pieces will be forced out to the _____. The bullet's exit hole will form an irregular oval as it exits to the right.
  - If the shot originated at an angle coming from the right, glass pieces will be forced out to the _____, leaving an irregular oval hole to the left.



shot perpendicular to the window *shot from the left* *shot from the right*

If the glass completely shatters, it is important to be able to tell which side the impact came from.

- If an object (fist, rock, hammer, etc) strikes a piece of glass that is large enough to shatter it, the majority of the glass will be on the _____ side of impact
  - Momentum will carry glass in direction object is moving
  - Only a small amount of glass called "_____" will originate towards the impact