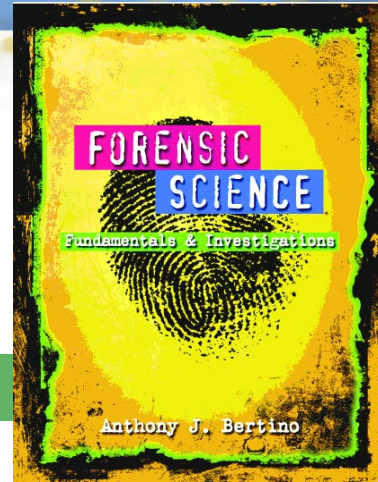


Chapter 14 *Glass Evidence*

By the end of this chapter you will be able to:



- Explain how glass is formed
- List some of the characteristics of glass
- Provide examples of different types of glass
- Calculate the density of glass
- Use the refractive index to identify different types of glass
- Describe how glass fractures
- Analyze glass fracture patterns

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Introduction and History of Glass

- Egypt circa 2500 B.C.—The earliest known human-made glass objects (beads)
- 1st Century B.C.—glass blowing begins
- 13th Century—specialized glass production was an art, a science, and a state secret in the republic of Venice



Introduction and History of Glass

- o 14th Century—glass-making spreads through Europe
- o The industrial revolution applies mass production to many types of glass
- o Analysis of glass found at a crime scene can yield trace evidence



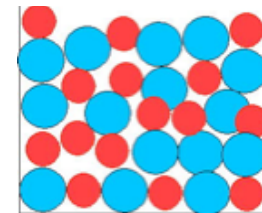
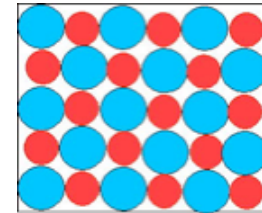
What Is Glass? Molten sand

- Materials used to create (soda-lime) glass:
 - Silicon dioxide (SiO_2) - sand
 - Sodium oxide (Na_2O)
 - Calcium oxide (CaO)
- Once cooled, glass can be polished, ground, or cut



What Is Glass?

- Crystalline solids have a regular atomic structure
- Glass is an amorphous solid and so has an irregular atomic structure
- Therefore, glass breaks in a variety of fracture patterns





Types of Glass classified by:

- Substance making up the glass
 - Note: adding metal oxides yields different colors
- Different densities
- Refraction indexes

-These characteristics allow comparisons



Density

The formula for calculating density is:

$$D = m / V \text{ (g/mL)}$$

m = mass, V = volume

Type of Glass	Density (g/ml)
Window glass	2.46-2.49
Lead crystal	2.9 – 5.9
Pyrex (cooking/lab)	2.23-2.36
Tempered (auto)	2.98
Porcelain	2.3-2.5

Borosilicate – similar



Refractive Index

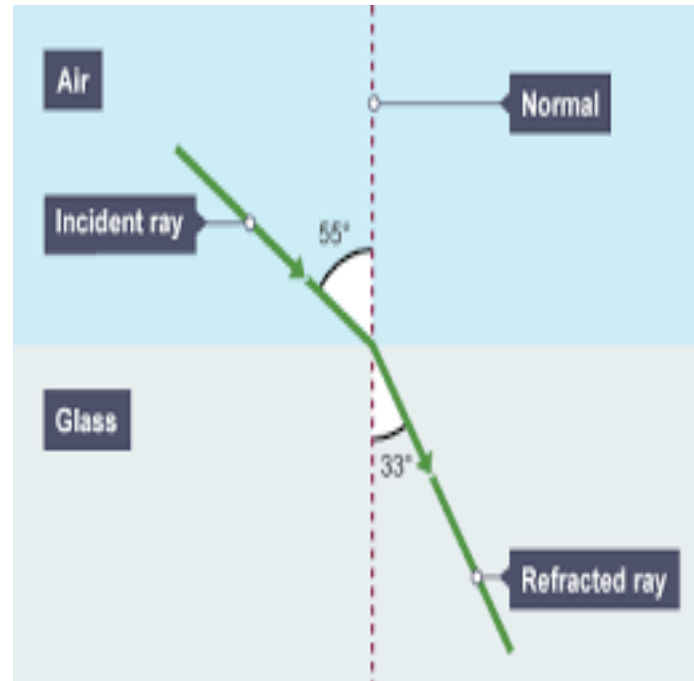
- When a beam of light moves from one medium into another:
 - The speed changes and the direction bends
- **Refractive Index (n)**—a tool used to study how light bends as it passes from one substance to another.
 - $c = \text{speed of light (300,000 km/sec)}$
 - $n = c \text{ in vacuum} / v \text{ in medium}$
- **Normal line** is perpendicular to interface surfaces of two mediums.



Refractive Index

When a beam of light moves from **less** dense medium (air) into a **more** dense medium (glass):

- Its speed **slows**, and
- Bends light **toward** the normal line





Refractive Index

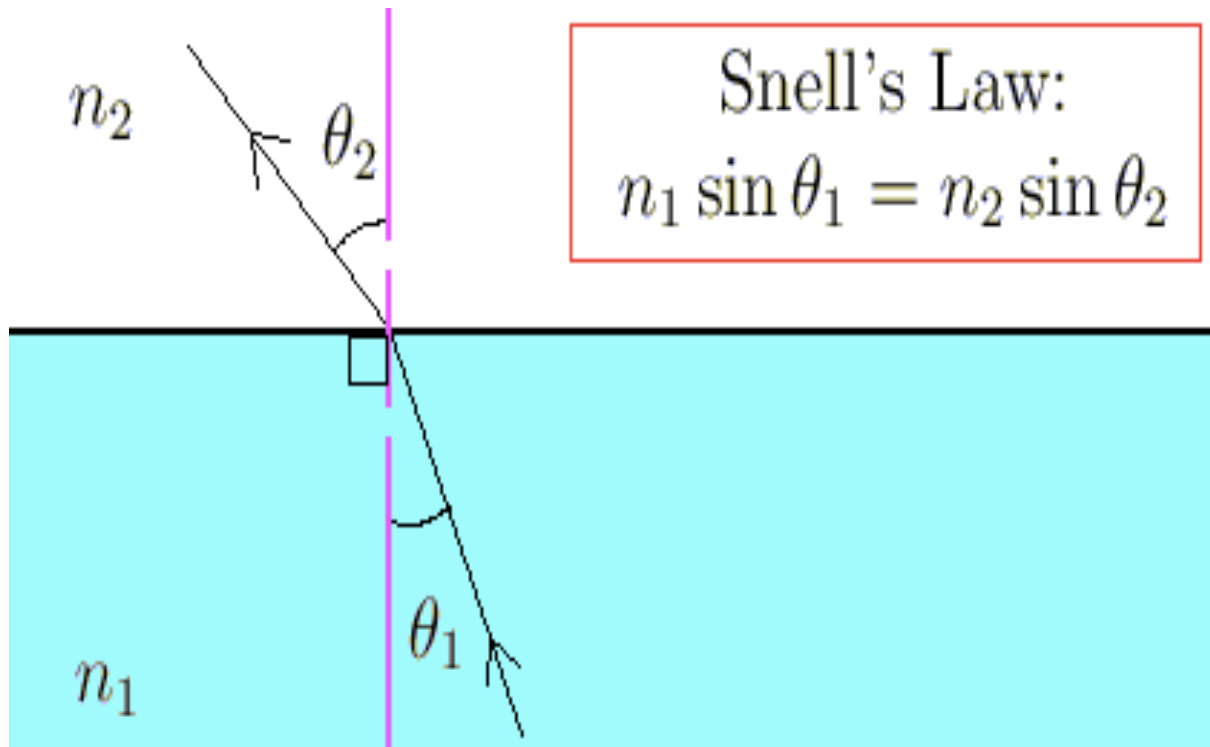
When a beam of light moves from a **more** dense medium (glass) into a **less** denser medium (air):

- Its speed **increases**
- And bends light **away** from the normal line



Snell's Law of refraction

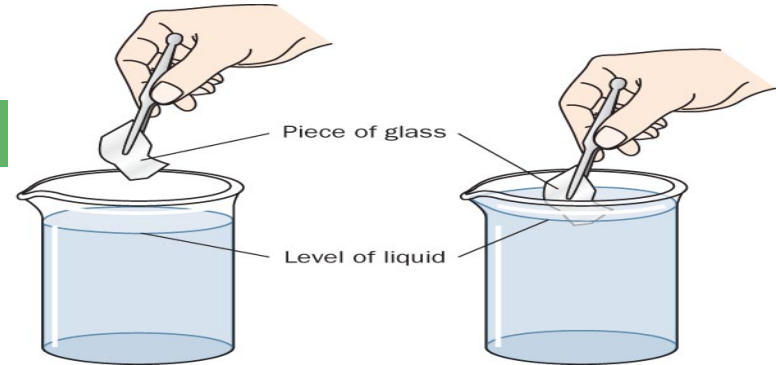
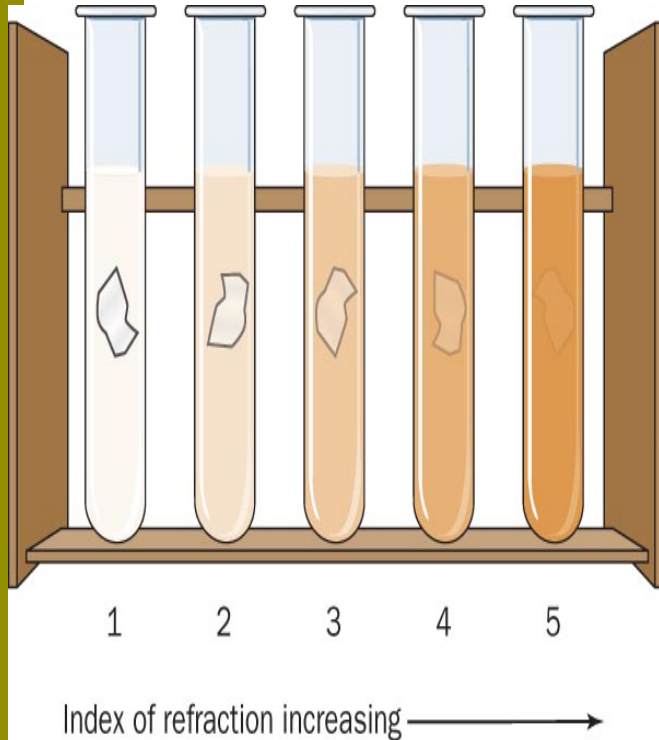
- formula that shows the relationship between angle of incidence and refraction angle



Application of Refractive Index to Forensics

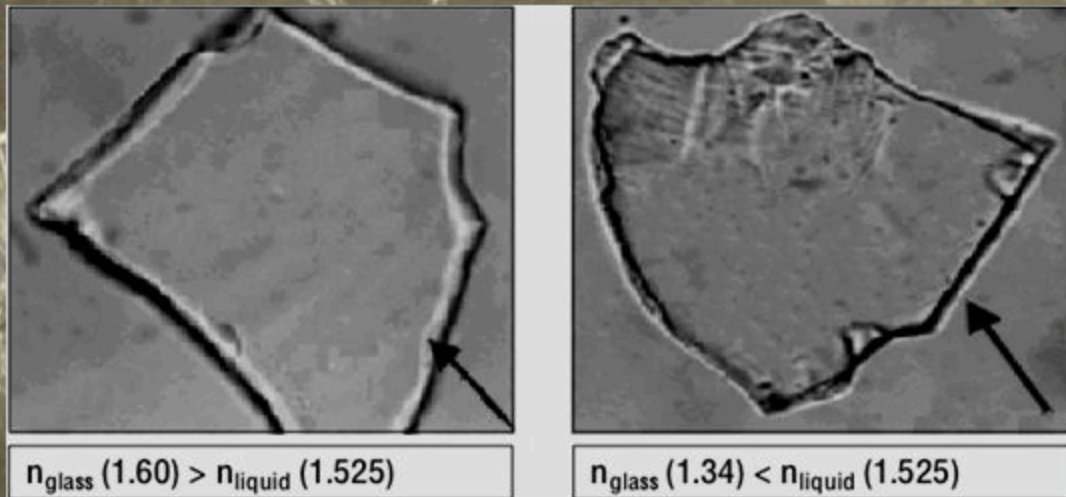


Submersion method



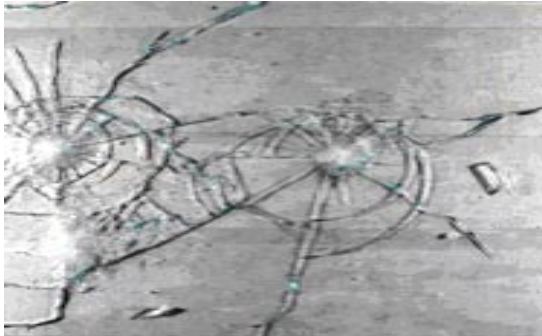
- Place the glass fragment into different liquids of known refractive indexes
- The glass fragment will seem to disappear when placed in a liquid of the same refractive index

The Becke Line



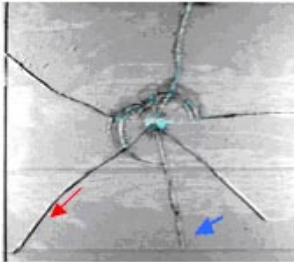
The Becke line is a “halo” that can be seen on the inside of the glass on the left, indicating that the glass has a higher refractive index than the liquid medium. The Becke line as seen on the right is outside of the glass, indicating just the opposite.

Fracture Patterns in Broken Glass



- o Being an amorphous solid, glass will not break into regular pieces with straight line fractures
- o Fracture patterns provide clues about the direction, rate, and sequence of the impacts

Why Radial and Concentric Fractures Form

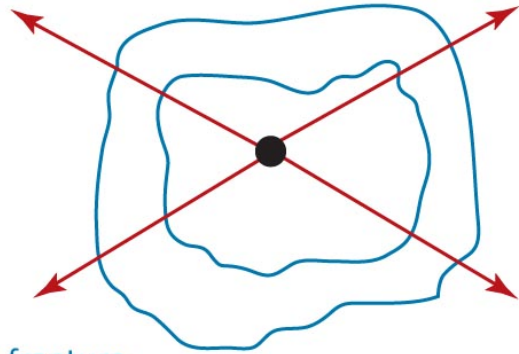


- Impacted glass is compressed on the side it is hit.
- It will stretch on the opposite side of the glass, and the tension there will radiate breaks in the glass outward from the point of impact.
- Then fractures form in the shape of concentric circles on the same side of the impact.



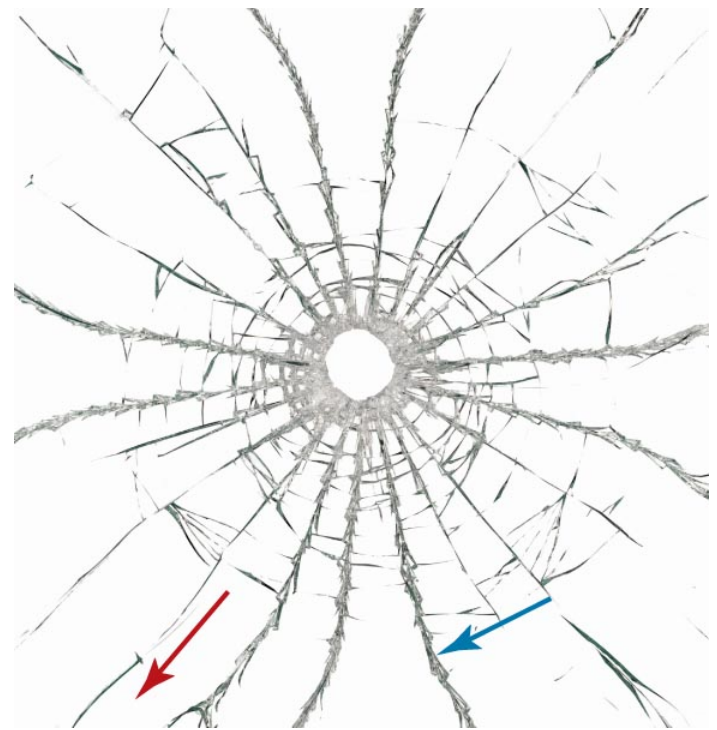
Why Radial and Concentric Fractures Form

Radiating fracture



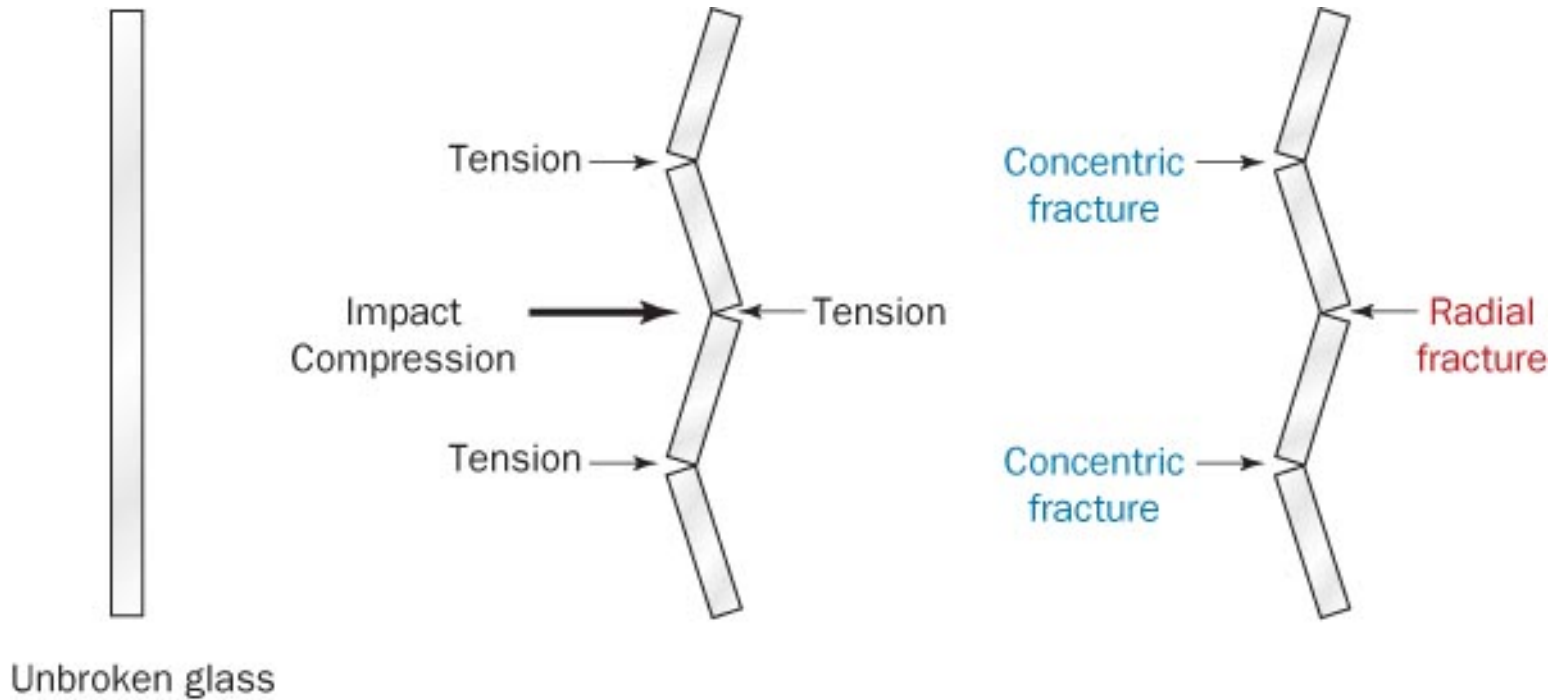
Concentric fracture

Glass after an impact shows radial fractures (red) and concentric circle fractures (blue)





Why Radial and Concentric Fractures Form





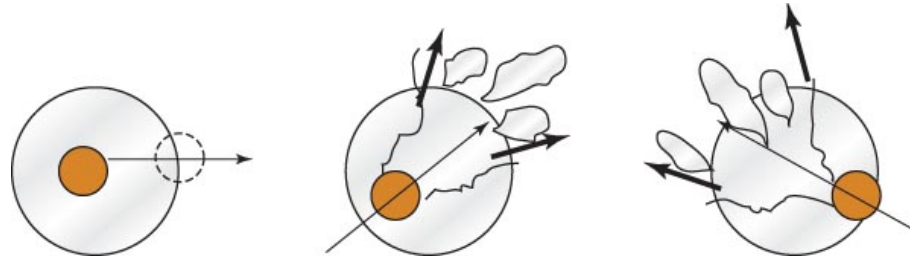
Bullet Fractures



- As a bullet passes through glass, it pushes a cone shaped piece of glass out of the glass ahead of it
- The exit side of the hole is larger than the entrance side of the hole
- Radiating fracture lines from a subsequent shot will stop at the edge of the fracture lines already present in the glass



Path of a Bullet Passing through Window Glass



perpendicular
to the glass

shot from
the left

shot from
the right

- The angles at which bullets enter window glass help locate the position of the shooter
- Bits of the glass can fly backward (backscatter), creating trace evidence

Handling of Crime Scene Glass Samples



1. Identify and photograph any glass samples before moving them.
2. Collect the largest fragments that can be reasonably collected.
3. Identify the outside and inside surface of any glass.
4. If multiple panes are involved, make a diagram.
5. Note trace evidence such as skin, hair, blood, or fibers.
6. Package all materials collected to maintain the chain of custody.



..... Summary

- o Glass is an amorphous solid
- o Glass can be analyzed for its density, refractiveness, and fracture patterns
- o Density of glass = Mass (grams) divided by Volume (milliliters)
- o Refractive index is a measurement of how light bends, or refracts, as it travels through a material



Summary

- Methods for measuring the refractive index include:
 - Snell's law
 - Submersion method
 - Becke line method
- Fracture patterns provide information about such things as the direction, the rate, and the sequence of the impacts