

Name \_\_\_\_\_ Block \_\_\_\_\_ Date \_\_\_\_\_

An investigation of two **physical properties** of matter.....**Density** and **Refractive Index**

**Crime Scene:** During a burglary, a glass object has fallen off a table onto the floor. The floor has no carpet covering and the glass object has shattered. If the burglar was near the object when it shattered, perhaps small fragments of glass can be found lodged in his clothing, especially in the lower trouser leg areas or the soles of his (or her !) shoes. A suspect is apprehended and his living quarters searched. A pair of pants is found which does indeed have glass fragments in the fibers and a few fragments of glass are removed from one pair of his shoes. Density and Refractive Index determinations are to be done in an attempt to prove the glass found in the suspects pants and shoes are of the same type of glass found at the scene. You are the forensic scientist. Run these tests to show how determinations are made.

**Density Comparison by Flotation:** Determine the relative **density** of ice by adding increasing amounts of isopropyl alcohol to 40 ml of water **until the ice is suspended** in solution. At this point you have reached the density of the ice.

Trial 1	40 ml H <sub>2</sub> O	+	_____ ml OH
Trial 2	40 ml H <sub>2</sub> O	+	_____ ml OH
Trial 3	40 ml H <sub>2</sub> O	+	_____ ml OH
Trial 4	40 ml H <sub>2</sub> O	+	_____ ml OH
Trial 5	40 ml H <sub>2</sub> O	+	_____ ml OH
Trial 6	40 ml H <sub>2</sub> O	+	_____ ml OH

**Question:** If my suspect's glass can be **suspended** in bromoform (l) whose known density is 2.89, which type of glass could we have?

(Hint: Use the chart below with several known densities of common materials)

<u>Material</u>	<u>Density</u>
Celluloid	1.4
Porcelain	2.3-2.5
Window Glass	2.47-2.56
Headlight Glass	2.47-2.63
Quartz	2.65
Flint Glass	2.9-5.0

**Answer:** \_\_\_\_\_

**Crime Scene:** A woman has been beaten and sexually assaulted in a park while walking back to her apartment from work. The crime took place at approximately 11 pm. The assault took place in an area where the ground was damp, and the investigating officers noticed that the soil was compressed in one area, as if the assailant's knee had gouged into a soft place in the earth. The victim has picked one of 3 men out of the lineup, stating that he was her attacker. The officers have a search warrant to look through the man's apartment for a pair of pants that might contain a dirt sample to be compared with the control sample from the crime scene.

**Density Comparison by Gradient Tubes:**

**Flotation** occurs in a liquid medium of greater density, **sinking** in a liquid of lower density or remains **suspended** in a liquid of equal density. Several gradient tubes are setup with 2 ml bromobenzene and 1ml of bromoform. Using several ionic salts decide which dirt "crystals" will float, sink or become suspended.

Bromobenzene's (d = 1.52)

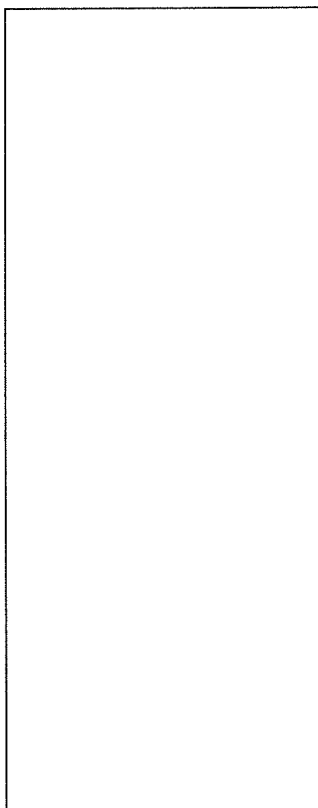
Bromoform's (d = 2.89)

Dirt crystal densities:  $\text{KNO}_2$  (1.91),  $\text{MgSO}_4$  (2.66),  $\text{KMnO}_4$  (2.70),  $\text{KCl}$  (1.98),  $\text{NaCl}$  (2.16)

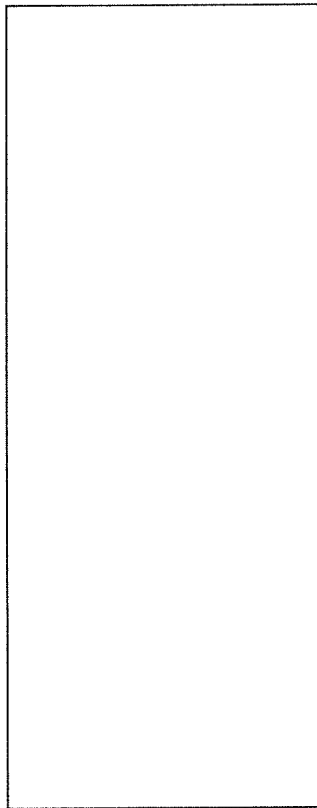
Draw the dirt "crystals" settled in the gradient tubes after 24 hrs. Label each crystal.

**Hint:**  $[(2\text{ml}) \times (1.52)] + [(1\text{ml}) \times (2.89)] = [\text{Total V} ( \_\_\_\_ ) \times \text{New density} ( X )]$

**Hypothesis**



**After 24 hrs.**



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**Refractive Index (RI) of Glass Fragments** - Measure the bending of a ray of light as it passes from air into a solid or liquid of different densities.

Find the (RI) of .....

Flint Glass

Corn Oil

$$n = \frac{\sin \text{incident } \angle(30)}{\sin \text{refracted } \angle( )} =$$

$$n = \frac{\sin \text{incident } \angle(60)}{\sin \text{refracted } \angle( )} =$$

So what does this have to do with solving the crime?

**Forensic Terminology:**

**Becke Line** = A colored boundary or "**halo**" **exists** around a transparent object when placed into a liquid with a **different (RI)**.

**Question:** What do you think would happen to the halo if you placed your piece of glass into a liquid with the **same (RI)** ? \_\_\_\_\_

**Investigation:**

- A) Place your suspect's evidence in each of the three liquids.
- B) When the glass is most transparent we are very close to matching the (RI) of the liquid and the solid.
- C) Use the tables below to identify where your sample of glass originated.

<b><u>Medium</u></b>	<b><u>RI</u></b>	<b><u>Medium</u></b>	<b><u>RI</u></b>
Water	1.333	Headlight Glass	1.47-1.49
Olive Oil	1.467	Window Glass	1.51-1.52
Castor Oil	1.482	Flint Glass	1.52-1.66
Clove Oil	1.543		
Soy Oil	1.380		
Corn Oil	1.470		

**Question:** What type of glass was found in the suspect's pants and on his shoes?

**Answer:** \_\_\_\_\_

\* **FYI:** In the **real world** different types of glass serve different purposes. For example, tempered glass in car windshields is made with different **metal oxides** than the Pyrex used to cook foods in. Even though they don't look different they each have a distinct **Physical Characteristics** known as **Density** and **Refractive Index**.