**RI of Glass by Submersion Lab Key**

**Teacher’s Tips:**

* Pea-sized glass fragments work well.
* Set up a demonstration rack for clove and castor oil and perhaps cinnamon oil as they are expensive for student use.
* Test tubes with oil are difficult to clean, so you may want to use the same tubes from one lab period to the next. After use, clean them with soap and a test tube brush, turn them over in the rack and let them drain thoroughly.
* The lowest refractive index in which the glass disappears will be the closest to the refractive index for that sample of glass. Some sample values follow. Borosilicate glass in olive or vegetable oil works well, as does quartz in clove oil.

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|  | **Source of glass** |  |  | **Refractive Index** |  |  |
|  |  |  |  |  |
| Borosilicate glass | |  | 1.47 | |  |  |
| Automotive headlight glass | |  | 1.47 – 1.49 | |  |  |
| Television glass | |  | 1.49 – 1.51 | |  |  |
| Pane window glass | |  | 1.49 – 1.51 | |  |  |
| Bottle glass | |  | 1.51 – 1.52 | |  |  |
| Eyeglass lenses | |  | 1.52 – 1.53 | |  |  |
| Quartz glass | |  | 1.54 – 1.55 | |  |  |
| Lead glass | |  | 1.56 – 1.61 | |  |  |
| Cubic zirconium | |  | 2.14 | |  |  |
| Diamond | |  | 2.42 | |  |  |

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|  | **Liquid** |  |  | **Refractive Index** |  |  |
|  |  |  |  |  |
| Cinnamon oil | |  | 1.62 | |  |  |
| Clove oil | |  | 1.54 | |  |  |
| Castor oil | |  | 1.48 | |  |  |
| Vegetable oil | |  | 1.474 | |  |  |
| Olive oil or glycerin | |  | 1.47 | |  |  |
| Isopropyl alcohol | |  | 1.37 | |  |  |
| Water or methanol | |  | 1.33 | |  |  |

**Materials:**

* 5 – 7 test tubes
* Test tube rack
* Test tube brush
* Tweezers
* Soap
* 25ml graduated cylinder

**Evidence Bags:**

Before the lab, three evidence bags containing glass need to be prepared for each team. At least one of the glass fragments of Suspect 1 or 2 should match the glass fragments in an evidence bag.

The evidence bags should be sealed using the proper chain-of-evidence format. The bag should be sealed with the name or initials of the crime scene technician. The name should be signed across the interface of the bag and the tape. The Chain of Possession form should have at least one name, date, and time entered before the student receives the evidence bag.

**Instructions:**

1. Prepare the test tubes with about 10ml of the each of the above liquids (your teacher may have other liquids and you will be given their refractive indexes).
2. Test each piece of glass in each type of fluid with tweezers. The glass will seemingly disappear in the fluid that has a matching RI.
3. Use the matching RI to determine what type of glass your evidence is.

**Questions:**

1. Based on the results of your submersion test, record the estimated refractive indices for each of the glass fragments.

The Refractive Index (RI) of the Crime scene glass = \_\_\_\_\_\_\_\_

The Refractive Index (RI) of the glass from Suspect 1 = \_\_\_\_\_\_\_\_

The Refractive Index (RI) of the glass from Suspect 2 = \_\_\_\_\_\_\_\_

1. What would you consider to be some experimental errors using this method?

**Answers may vary. Possible sources of error include**

* 1. **Using the same piece of glass to test in the different solutions**
  2. **Washing the glass piece may alter the evidence**
  3. **Not having large enough pieces of glass**
  4. **Not thoroughly cleaning the glass prior to submersion**

1. What could you do to improve the reliability of this experiment?

**Answers may vary.**

* 1. **If enough evidence was available, use a different piece of glass before doing each submersion test.**
  2. **Try to find pieces of glass that are all approximately the same size.**
  3. **Repeat the submersion test and check that you got the same results.**
  4. **Confirm your findings with other members of the class.**
  5. **Have more solutions with different refractive indexes to be able to more closely determine the refractive index.**

4. Is your match conclusive? Why or why not?

**Answers may not be conclusive if the glass fragment did not disappear and remained slightly visible. That would mean that the refractive index of the solution was not exactly the same as the refractive index of the glass.**

1. Why would the match of glass from the crime scene to a suspect be considered class evidence?

**The glass may not be unique. For example, bottles (juice, milk, etc.) manufactured by the same company could all have glass at the same refractive index. The glass fragment of the trophy case could be the same as the glass fragments from a different window.**

1. Explain the refraction of light. Include in your answer the following:
   * Two different mediums
   * Light velocity
   * Density

**Refraction of light is referred to as the bending of light as it passes from one medium through another. The bending occurs because of a difference in density between the two mediums. If one medium is denser than the other, the velocity of light slows down, resulting in the bending of the light.**

1. A refractive index of olive oil is equal to 1.47. It is calculated as a ratio between what two numbers?

**The refractive index of olive oil is calculated as a ratio between the speed of light in a vacuum and the speed of light through olive oil.**