Vanishing Glass

Amount of time Demo takes: 1 minute

Try this at home!

Lesson's Big Ideas

- Objects that allow light to pass through (transparent) bend the light as it moves through the object.
- The degree to which the light is bent is measured by the refractive index.
- Different materials have different refractive indexes.
- Pyrex and water have different refractive indexes, while the indexes of Pyrex and vegetable oil are nearly identical.

Materials

- 400ml Pyrex beaker (2)
- 800ml Pyrex beaker (1)
- Pyrex test tubes (2)
- Glass stirring rods (optional)
- Light in color vegetable oil
- Paper towel

SAFETY!

- Glassware will be slippery; always keep glassware over the table and handle it with care.
- If glassware breaks, sweep all glass into a trash bag-lined cardboard box and tie the bag tightly. Label the box as containing BROKEN GLASS. **Do not** handle broken glass with bare skin - it is sharp.

Background Information

- **Refractive Index:** The number assigned to a medium or substance based on how fast light travels through that medium. The refractive index is a unitless ratio. The equation to find refractive index is: $n = \frac{c}{v}$ Where **n** is the index, **c** is the speed of light (in a vacuum), and **v** is the speed of light

in the medium. So, basically, the higher the ratio, the more the light bends as it passes through the material. For reference, here are some common refractive indexes:

Ice - 1.31
Human Cornea - 1.373
Water - 1.33
Air - 1.000293
Diamond - 2.42
Pyrex - 1.47
Vegetable Oil - 1.47

- When you look at or through an object, you're not really seeing that object, you're seeing light that bounces off or moves through that object. The reason you see clear objects is that light moves slower when it passes through them than the light that does not. Unless the object is perfectly smooth, light is also bent as it passes through the object, which is why objects seen through materials like Pyrex have a curved look to them. It's because the light itself has been curved.
- We can see clear objects because there is a difference in refractive index; the Pyrex beaker and the air beside the beaker have different indexes, meaning that light moves through them at different speeds. It is this difference that allows us to see where the beaker is. If there is no difference, we cannot tell where the object is. It is invisible relative to those materials around it that share the index of refraction.

Setup Instructions

1. Set out the glassware, make sure it is clean.
2. Fill the 800 ml beaker with 400 ml of water and 400 ml of oil (measurements do not need to be precise).
3. Lay out a paper towel to absorb stray water/oil.
4. Fill one 400 ml beaker with water.
5. Place test tubes in the empty 400 ml beaker. This is the tube holder.

Instructional Procedure

1. Show the students what happens when a test tube is put into the 400ml beaker filled with water. Explain refractive index and why we are able to see the test tube.
2. Ask for predictions of what will happen when the tube is submerged in oil.

3. Submerge the tube in the oil/water solution (make sure that the tube is highly visible for when it appears to disappear).

Tips & Tricks

- The brand of vegetable oil can impact the effect of this demonstration. Buy a brand that is lighter in color, rather than more yellow. You may want to experiment with a couple different brands to determine which works best.
- You could use different size beakers and test tubes to show how each one reacts.

Assessment Questions

1. Does light go the same speed all the time?
    a. No, light will be slowed down when it goes through different objects.
2. How can we measure how fast light moves?
    a. The speed of light through an object can be calculated using this equation: $n = \frac{c}{v}$ We already know **c** which is the speed of light, and we know **n** which is the refractive index. So once you solve the equation, you know how fast the light moves through the object.
3. What will happen when the test tube is submerged in water? Oil? What's the difference?
    a. When the test tube is submerged in water, you will still be able to see it. However, when the tube is submerged in oil, it will appear to have disappeared. The oil has the same refractive index as the Pyrex, which allows for the Pyrex to 'disappear'.

Careers & Real-World Applications

- Photographer - the flash is used to emit more light on a scene to capture a more vivid photo. The camera will take the picture at the same time the flash goes off. If it doesn't match up, the flash won't improve the photo quality as intended.
- Radiology technician - they use x-rays to see through the body. X-rays are a type of electromagnetic radiation that allow bones and organs to be seen.

Clean Up

- Pour all the oil back in the container and screw the lid on TIGHTLY.
- Wipe, clean all pyrex glass and wrap it in bubble wrap for transit. Whenever possible use soap and a sponge to clean everything out thoroughly!
- Ensure all supplies are not oily or wet when put away

References

- http://en.wikipedia.org/wiki/Refractive_index
- http://www.youtube.com/watch?v=Wif_yGZcK18
- https://www.microscopyu.com/microscopy-basics/refractive-index-index-of-refraction

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