SNC2D/2P Light and Geometric Optics/Light and Applications of Optics

Teacher Demo/Student Activity: Disappearing Beaker

Topics	Timing
refraction of light index of refraction	preparation: 10 min demonstration/activity: 10 min

Specific Expectations

SNC2D

A1.1 formulate scientific questions about observed relationships, ideas, problems, and/or issues, make predictions, and/or formulate hypotheses to focus inquiries or research

A1.8 analyse and interpret qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis, identifying possible sources of error, bias, or uncertainty

A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions

E3.4 explain the conditions required for partial reflection/refraction and for total internal reflection in lenses, and describe the reflection/refraction using labelled ray diagrams

E3.7 identify the factors, in qualitative and quantitative terms, that affect the refraction of light as it passes from one medium to another

SNC2P

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A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions

E3.4 describe qualitatively how visible light is refracted at the interface between two different media

Introduction

This demonstration will amaze and astound! As you pour vegetable oil into a small Pyrex beaker placed inside a larger Pyrex beaker, the smaller beaker will magically disappear! It could be a teacher demo or a student activity.

Materials

- vegetable oil (500 mL for teacher demo; 200 mL/group for student activity)
- 500 mL Pyrex beaker with as few markings as possible
- 50 mL Pyrex beaker with as few markings as possible
- paper towel

Safety Considerations

None

Procedure

Ensure that all participants are wearing appropriate PPE: chemical safety goggles and lab coat or apron.

1. Before the beginning of class, place some paper towels on the lab bench or desk and place the large Pyrex beaker on the paper towels. Place the small Pyrex beaker inside the large beaker. If performed as a demonstration, ensure that all students will have a good view. A video camera could be used for extra large classes.
2. **Predict/Explain**
   Organize your class into groups of 2 to 4 students. Ask each group to predict what will happen to the smaller beaker when you pour vegetable oil into it until the oil starts to overflow, filling the outer beaker. Encourage each group to provide a rationale for their prediction.
3. **Observe**
   Start to fill the smaller beaker with vegetable oil. Keep pouring oil into the beaker, letting the oil overflow and start to fill the larger beaker. Continue filling the beakers until the smaller beaker completely disappears. Provide time for students to record their observations.
4. **Explain**
   Ask the small groups to reconvene and revise their explanations, if necessary. Challenge them to visually communicate their explanation of their observations." If necessary add a hint: "Try drawing a ray diagram for the demonstration."
5. If this is a student activity, collect the used vegetable oil in a large container. Students could wash their beakers carefully with soap and water.

Disposal

Recycle the vegetable oil: store it and re-use it next year to minimize waste and cost. Wash and store the beakers.

What happens?

The smaller beaker disappears as the vegetable oil starts to fill the larger beaker.

How does it work?

For an object to "disappear" and become invisible from any angle of view, the object must not reflect, refract, or absorb any incident light. This can happen if a transparent object is placed in a transparent liquid with an index of refraction that matches the object. Pyrex and vegetable oil both have the same index of refraction (n = 1.47) so a small Pyrex beaker disappears when immersed in vegetable oil. Since the light is not reflected, refracted, or absorbed, it is as though there is nothing there except for the oil. Normal glassware (with a refractive index in the range of n = 1.5 to 1.7) will not disappear in vegetable oil. Pyrex glassware will not disappear if submersed in water (n = 1.33).

Teaching Suggestions/Hints

1. This demonstration can be used as a powerful hook for the Light and Geometric Optics unit.
2. In Step 2 some students may predict that the smaller beaker will appear to be magnified.
3. In Step 3 students will observe that the smaller beaker begins to disappear.
4. You may choose to repeat this demonstration with a different type of fluid (such as water, syrup, or mineral oil) or a small beaker made of a different substance (glass, plastic).
5. Remind students to be very careful when washing the beakers: the oil and soap will make them very slippery.
6. For a real show-stopper (although it is more expensive and wasteful), hide a Pyrex test tube in an adequate quantity of vegetable oil in a large beaker before class starts. Mention to students that glassware sometimes gets broken in the lab. Proceed to break a Pyrex test tube. (Do this safely: wearing safety goggles and with the test tube wrapped in a towel.) Place the broken pieces of glass in the beaker of vegetable oil that contains the hidden test tube. After an "Abracadabra" or "Hocus Pocus," extract the unbroken Pyrex test tube with some tongs and watch the expression on your students' faces! The broken test tube can be stored in a sealed labelled container for future use.

Next Steps

Repeat the procedure using water instead of vegetable oil or a normal glass beaker instead of a Pyrex beaker.

There are very interesting connections between this demonstration and "invisibility cloak" technology. Scientists at the University of California at Berkeley have developed materials on a very small scale that bend light to make tiny objects disappear. The prospects of such technology are very intriguing.

Additional Resources

1. A more detailed explanation of the demonstration and related concepts - http://www.abc.net.au/science/surfingscientist/pdf/teachdemo27.pdf
2. Video of this demonstration - http://www.youtube.com/watch?v=R4jppRASI_U
3. Video of a similar demonstration - http://www.youtube.com/watch?v=wlELYZJ5JF4&feature=related
4. Another similar demonstration and explanation - http://stao.ca/scienceworks/survival-optics/StoreResources/HidingDiamonds.ppt