INVISIBLE GLASS EXPERIMENT

LEVEL

Level 3-Level 6 (Year 3- Year 6)

ACTIVITY DESCRIPTION

Watch glass disappear when it is placed in vegetable oil. This happens because pyrex glass and vegetable oil both have the same refractive index – they both bend light by the same amount. This activity is best done as a demonstration as oily glass is too slippery for students.

THEME

- Materials – solids/liquids
- Refraction
- Refractive index

ACTIVITY LENGTH

40 minutes

MATERIALS REQUIRED

- 1 large clear glass bowl or large beaker
- Vegetable oil
- Water
- 4 Pyrex test tubes
- 3 identical Pyrex beakers, 1 beaker will be used to fit into large bowl
- Rubber gloves
- Paper towel

INSTRUCTIONS

STEP 1. Prior to the demonstration, fill a large bowl with vegetable oil and sit beaker in it. This glassware will be 'hidden' throughout the demonstration and will be revealed at the end. Wear long rubber gloves when dipping the glassware in the vegetable oil.

STEP 2. Fill 1 beaker with water and 1 beaker with water and oil (water on the bottom, oil on the top).

STEP 3. Start the demonstration by dipping a Pyrex test tube in water and emphasise the fact that when the test tube is filled with water it can be seen less but it is still visible.

STEP 4. Take another test tube and submerge it in the bowl filled with vegetable oil. Ensure the test tube has been filled with oil and ensure that there are no air bubbles trapped inside. Ask the audience whether the Pyrex glassware is still visible.

STEP 5. Explain the physics behind this phenomenon and then, at the end of the demonstration, remove the remaining "invisible" glassware from the large bowl in a big-reveal moment which will catch the audience by surprise.

STEP 6. Students to complete 'Invisible Glass Worksheet' or discuss Key terms and Key questions.

SUGGESTIONS FOR ASSESSMENT

Successful observation of experiment. Participation in class and small group discussions. Use of key vocabulary (see below) to explain observations. Successful completion of the worksheet.

BACKGROUND INFORMATION

WHY DID THIS HAPPEN?

When the Pyrex glass item was placed into the bowl of water, you may have noticed it looked different from how it looks in air. This is because light moves more slowly in water than in air. When light enters the water and slows down, the light bends. This is called refraction. The amount that light bends through a substance or an object is called its refractive index. When light enters the Pyrex object, it travels at a lower speed than it does through the water, so it is refracted further. This allows us to see the Pyrex object in the bowl of water. However, it just so happens that light travels through Pyrex glass at exactly the same speed as through vegetable oil. This means they have the same refractive index. So when the Pyrex is in vegetable oil, light from the air enters the oil and refracts. But when it enters the Pyrex, it doesn't refract any further, and keeps going at the same speed in the same direction. So to our eyes, the Pyrex object is invisible.

GLASS, OIL AND CRIME SCENES

Forensic scientists use an experiment like this to solve crimes when the crime scene includes glass fragments from smashed windows or windscreens. "I had a case where 3 windows were allegedly smashed with a hockey stick," says Dr Kari Pitts, forensic chemist at ChemCentre. "We took tiny glass fragments from the hockey stick and compared them with glass from the crime scene." In the lab, Kari put a glass fragment on a microscope slide with silicone oil and slowly heated it in a machine. "Heating the oil changes its refractive index," she says. "At a certain temperature, the edges of the glass fragment disappear." Using maths, Kari worked out the refractive index of the oil based on its temperature. This revealed the refractive index of the glass fragment. "There were about 20 or 30 fragments of glass on the hockey stick," she says. "They all had the same refractive index as windows from the crime scene!

KEY VOCABULARY

KEY TERMS

CLOAKING
A technique used to hide or partially hide an object by manipulating light waves.

ELECTROMAGNETIC WAVE
A family of waves which are formed by cyclical patterns in the electrical and magnetic fields in an environment. Electromagnetic waves include x-ray waves, visible light waves from the sun or an electrical light, and microwaves.

FRESNEL'S EQUATIONS
A set of equations describing the behavior of light when it moves between media that have different refractive indices.

METAMATERIALS
A material constructed in such a way that it has special properties not found in nature.

OPTICAL MEDIUM
A material through which a light wave can pass, for example water or glass.

REFRACTIVE INDEX
A property of an optical medium which determines by how much light is bent when it passes through the optical medium. This bending occurs because the refractive index affects the propagation of light through the medium.

REFLECTION
Occurs when there is a change in the direction of a wavefront at a boundary such that wave returns into the medium from which the wave originated, such as when light bounces off a mirror on a wall and back into a room.

REFRACTION
Occurs when there is a change in direction of a wavefront at a boundary due to a change in the medium through which it is traveling. Wave Propagation describes the way in which electromagnetic waves travel.

KEY QUESTIONS

Why does Pyrex become invisible in the vegetable oil?

Because Pyrex has exactly the same refractive index as the vegetable oil.

What is the refractive index?

The refractive index is a property of a material that determines by how much light is bent as it passes through the material.

How is the refractive index of a material calculated?

It is the ratio of the velocity of light through a vacuum to the velocity of light through the particular material.

Why does light bend as it passes from one medium to another?

Because it travels with a different speed through different media.

Hows is refractive index linked to the speed of the light waves traveling in a medium?

Light passes more slowly through a material with a larger refractive index when compared to a material with a smaller refractive index

MORE RESOURCES

The accompanying student worksheet explores an application in forensics. This textbook sample chapter [PDF] about forensic glass testing will give you a good background in the topic if you want to explore it in more detail.

GENERAL INFORMATION

Short video of how a steam engine works

How does a Steam Locomotive work?

https://www.youtube.com/watch?v=wZSoMxTb1ZM

CURRICULUM LINKS

SCIENCE UNDERSTANDING

Level 5: Light from a source forms shadows and can be absorbed, reflected and refracted ACSSU080

SCIENCE AS A HUMAN ENDEAVOUR

Level 5 and 6: Scientific knowledge is used to solve problems and inform personal and community decisions ACSHE083, ACSHE100

SCIENCE SKILLS

Level 3 and 4: Reflect on investigations, including whether a test was fair or not ACSIS058, ACSIS069
Level 5 and 6: Reflect on and suggest improvements to scientific investigations ACSIS091, ACSIS108

INVISIBLE GLASS WORKSHEET

DRAW YOUR OBSERVATIONS OF THIS EXPERIMENT BELOW:

INVISIBLE GLASS WORKSHEET

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