The Magic of Bending Light: Exploring Refraction

Materials Needed

- Clear drinking glass, fishbowl, or jar
- Water
- Pencil, straw, or stick
- Small coin (penny or dime)
- Sheet of plain paper and markers/pen
- Tape (optional, for securing paper)
- Small bowl or opaque mug (for the coin trick)

Universal Learning Objectives

By the end of this lesson, learners will be able to:

1. Define refraction in simple, observable terms.
2. Successfully perform and describe at least three real-world examples of light refraction.
3. Explain conceptually why light bends when it moves from one transparent medium (like air) to another (like water).

Lesson Structure

Part 1: Introduction (Tell Them What You'll Teach) - 10 Minutes

The Hook: A Broken Pencil Magic Trick

Activity: Place a pencil halfway into a clear glass of water. Have the learner observe the pencil from the side.

Discussion Prompt: Does the pencil look whole, or does it look broken or bent? If you know the pencil is straight, what is making it appear this way?

Objectives Review

Today, we are going to become light scientists. We will learn how light travels and why it sometimes appears to "break" things, perform optical illusions, and help us see underwater. This phenomenon is called **refraction**.

Part 2: Content and Guided Practice (Teach It) - 30 Minutes

I Do: Defining Refraction and Mediums (Modeling)

Concept Presentation: Refraction is simply the bending of light as it passes from one transparent substance (called a **medium**) to another.

Analogy: Imagine you are riding a bicycle very fast on smooth pavement (Medium A: Air). Now,

imagine trying to ride that bicycle into deep sand (Medium B: Water). As soon as the wheel hits the sand, it slows down and changes direction.

- Light travels fastest in a vacuum (like space).
- It travels slightly slower in air (our atmosphere).
- It travels much slower in water or glass.

When light hits a new medium at an angle, the side of the light ray that hits first slows down, causing the entire ray to turn or bend. This bending is refraction.

We Do: Experiment 1 – The Bent Pencil (Reviewing the Hook)

Success Criteria: The learner can accurately observe the apparent bend and correctly identify the two mediums causing the refraction.

1. Fill the glass with water.
2. Place the pencil or straw into the water at an angle.
3. Observe the pencil from various angles (above, directly through the side, and obliquely).

Discussion:

- Where does the pencil appear to bend? (At the surface line where air meets water.)
- When you look at the part of the pencil in the water, is the image closer or further away than the actual pencil? (It appears closer/shallower.)

We Do: Experiment 2 – The Vanishing Coin (Application)

Success Criteria: The learner can explain how changing the viewing angle, and then adding water, makes the coin appear or disappear.

1. Place the small coin flat on the bottom of an opaque mug or bowl.
2. Have the learner slowly move backward until the coin is *just* out of sight (hidden by the rim of the mug). Instruct them to hold their position.
3. The educator slowly pours water into the mug, being careful not to move the coin.
4. **Question:** Can you see the coin again?

Explanation: The light coming from the coin normally travels straight up and hits the rim, blocking your view. When we add water, the light rays coming from the coin bend (refract) as they exit the water and enter the air. This bending allows the light rays to bend *over* the rim and reach your eyes, making the coin magically reappear!

You Do: Experiment 3 – The Reversed Arrow (Independent Practice)

Success Criteria: The learner correctly sets up the apparatus and successfully observes the image reversal, explaining that it is caused by the bending of light rays through the curved water container.

1. Draw a large, bold arrow pointing to the right on the sheet of paper.
2. Tape or prop the paper so the arrow is standing upright (or have a partner hold it).
3. Stand the clear glass of water about 1-2 feet in front of the arrow.
4. Have the learner look at the arrow through the water glass.
5. Slowly move the paper further away from the glass until a strange thing happens to the arrow.

Observation & Reflection: At a certain distance, the arrow will appear to flip and point the opposite

direction! (The glass of water acts like a lens, using refraction to focus the light rays. When the paper is placed outside the focal point, the image is inverted.)

Part 3: Conclusion and Assessment (Tell Them What You Taught) - 10 Minutes

Formative Assessment: Quick Recap

Q&A/Think-Pair-Share:

1. In your own words, what is refraction? (The bending of light.)
2. What causes light to bend? (It changes speed when moving from one substance, or medium, to another.)
3. How did refraction help us see the coin in the cup? (The light bent over the rim to reach our eyes.)

Real-World Relevance

Refraction isn't just a fun trick; it’s essential! It is the principle behind:

- **Lenses:** Eyeglasses, cameras, and telescopes use curved glass lenses to precisely bend light and focus images onto your eye or sensor.
- **Rainbows:** Raindrops act like tiny prisms, refracting the white sunlight into the visible spectrum of colors.

Summative Assessment: Reflection and Documentation

Activity: The Refraction Scientist Log: Have the learner choose one of the three experiments (Bent Pencil, Vanishing Coin, or Reversed Arrow) and create a log entry documenting:

1. The goal of the experiment.
2. What they observed.
3. A simple drawing showing the path of the light rays (a straight line in air, a bent line in water).
4. Their explanation of *why* the effect happened (refraction/change in speed).

Differentiation and Adaptability

Scaffolding (For learners needing support)

- Use the bicycle/sand analogy multiple times to reinforce the speed change concept.
- Use thicker items (like a broom handle or large stick) in a wider container (like a bucket) to make the bent effect more dramatic and visible.
- Provide pre-drawn ray diagrams to help visualize the light path during the Vanishing Coin experiment.

Extension (For advanced or faster learners)

- **Advanced Application:** Challenge the learner to research Snell's Law (the mathematical formula for calculating the angle of refraction) and define the term *index of refraction*.
- **Creative Challenge:** Research the concept of a mirage (an optical illusion often seen in deserts or on hot roads) and explain how it is a form of atmospheric refraction.
- **Design Challenge:** If a laser pointer is available (use with extreme caution, never shining it near eyes), have the student shine the laser through a glass of water that has a few drops of milk added (to make the beam visible). Observe how the beam changes angle when it hits the water.