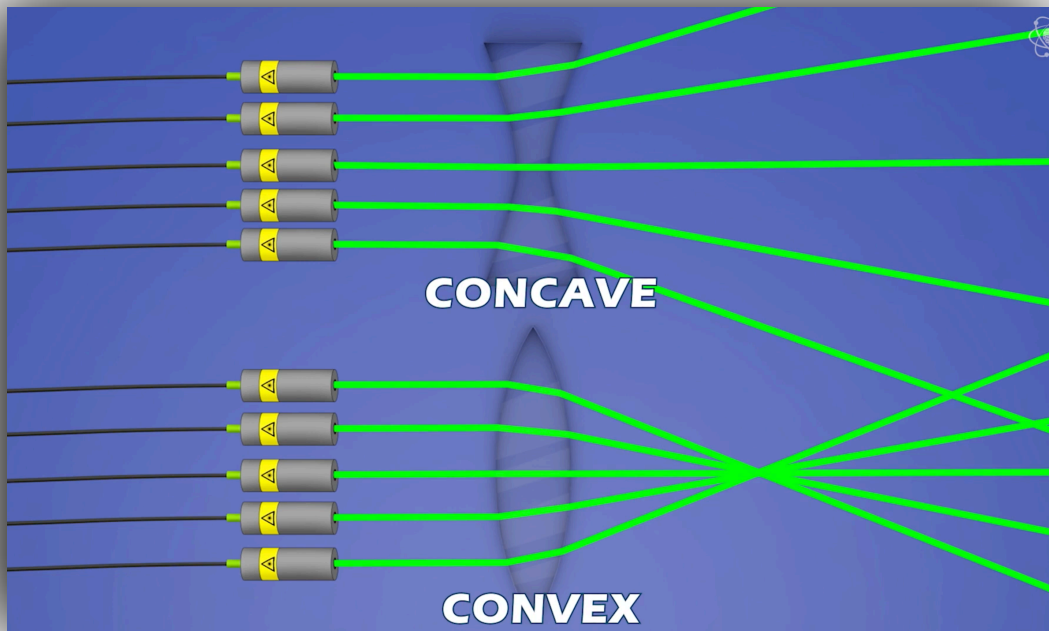


Refraction & Invisibility

Goal: Students will become aware of the concept of refraction and how it can be used to make objects disappear.

Standards: MS-PS4-2; MS-PS4-B



Procedure

1. Make sure each student or pair has a pen and a closed clear bottle filled with water. Wait until the end of the lesson to distribute the second pen.
2. Tell students that although you know that they are already experts at making pens and pencils disappear, today they will actually learn how to make a pen invisible.
3. Demonstrate the trick for them without the reveal, or show them the clip of Jason making his pen go inside the water bottle.
4. Place students in mixed-ability pairs or small groups, assigning roles (speaker, recorder) if necessary, and ask

Objective:

The student will be able to demonstrate an understanding of refraction through recreating an experiment.



Materials:

- two pens
- a clear bottle filled with water
- refraction and invisibility video
- an index card or piece of paper
- a pencil/pen
- a clear glass or plastic cup of water

them to try to recreate the trick on their own, coming up with a hypothesis about how the trick works.

5. After a few minutes, have a spokesperson from each group share their ideas.
6. Review vocabulary and show clip demonstrating refraction. Have students draw a diagram similar to the one in the video to deepen comprehension.

Vocabulary

Refraction: the bending of a light ray when it passes at an angle from one medium or substance into another in which its speed is different (as when light passes from air into water or glass and bends).

Concave: hollow or rounded inward as in the inside of a bowl. A concave lens is used to diverge or direct light away.

Convex: rounded like the outside of a ball. A convex lens is used to converge, or bring together, light rays to a point where the rays will actually cross.



7. Hand out second pen to students/groups, and ask groups to reconvene and come up with a second hypothesis knowing that there is a second pen involved, and that the trick involves refraction.
8. Call on a few groups to share. If teaching remotely, having students share hypotheses in chat is a nice way to incorporate writing while reaching quieter students.
9. Reveal the solution through showing the end of the video (and possibly demonstrating live).
10. Have students draw a straight line/arrow across an index card.
11. Students should hold the index card behind the glass of water.
12. Have students sketch a picture of what they observe happens to the arrow when it is held behind the clear glass of water.

13. Ask: Why does the arrow seem to bend when held behind the glass of water?
14. Have students work in pairs to observe what happens when other drawings are held behind the glass? What about straight objects (pencil, pair of scissors, ruler) placed in the glass of water? Why do they seem to bend?

Assessment:

Each student should write a short paragraph explaining how the trick uses refraction to make the pen disappear. Small groups should recreate the experiment.

If teaching remotely, students should send in a short video (or photos) where they recreate the trick for a friend or family member and explain refraction.

Modifications:

Challenge: Create a poster or powerpoint showing another demonstration of refraction. Suggest using a flashlight and magnifying glass or eyeglass lens and paper.

Remediation: Give students a written breakdown of how the experiment works, and have them explain it verbally to you after reviewing it.