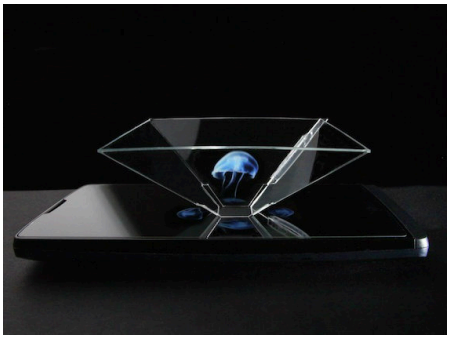
# Handheld Hologram

**Amount of time Demo takes: 2 minutes**

**Try this at home!**



## Lesson's Big Ideas

- A hologram is a type of photograph that captures scattered light from multiple surfaces of an object so that the image appears to be three-dimensional.
- Holograms are created using light interference and the Law of Reflection.

## Materials

- Hologram Projector
- Ipad or smartphone
- WiFi
- Cover to provide darkness

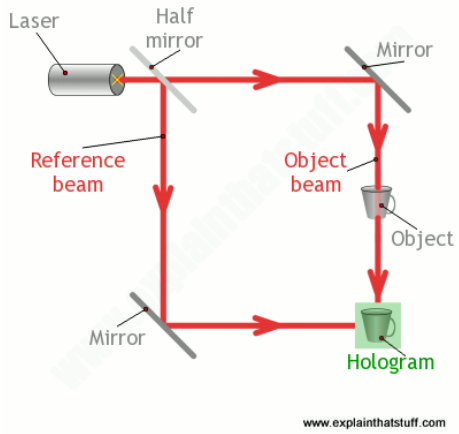
## SAFETY!

- **Safe demo!**

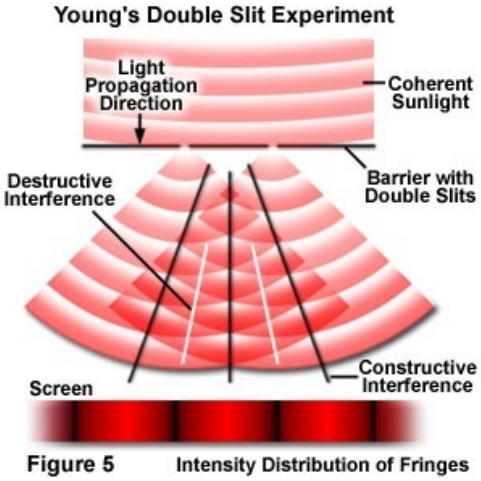
## Background information

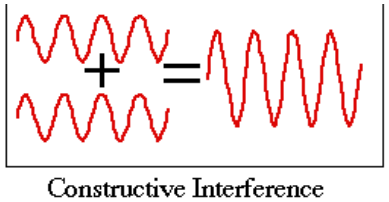
- History of Holography
    - The PepperGram Projector is a variation of an old illusion technique used in theaters and haunted houses in the 1800's called the Pepper's Ghost Illusion.
    - **1947:** A British scientist develops the theory of holography, while conducting his electron microscopy research. The term hologram was coined from the Greek words, holos ("whole") and gramma ("message").
    - **1960:** Russian scientists invent the laser. Its intense and pure light was needed for making holograms.
    - **1962:** Two researchers at the University of Michigan develop a side-reading radar, which may be used to record a 3D hologram

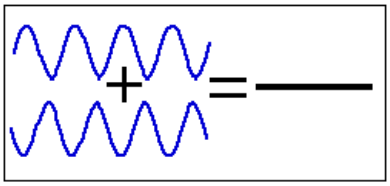
using laser light.
    - **1962:** A hologram that can be viewed using white-light (ex. Incandescent light bulb) is created.
    - **1972:** White-light transmission holography and conventional cinematography are combined to create moving 3D holograms.
- How Holography Works
    - Holograms are created by the interference of light. The pattern of interference (2+ beams of coherent light) is what gives the appearance of a 3D image.
        - **Coherent light:** light waves of the same wavelength and phase (i.e. laser).



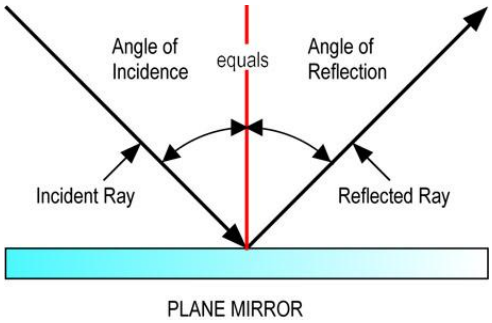

    - Interference is where two (or more) waves (ex. Light waves) coincide or combine to create a single light wave.
        - **Constructive interference:** light waves combine to create a larger amplitude wave.
        - **Destructive interference:** light waves cancel each other, resulting in a smaller (or zero) amplitude wave.





Constructive Interference


Destructive Interference

- The interference pattern created by the light is called a **standing wave**- called such because the pattern is “still” or constant. This phenomenon is why we can photograph these light images.
- The lights bounces off of surfaces according to the Law of Reflection. The **law of reflection** states that the angle of incidence (to the surface), equals the angle of reflection.




- Images reflecting off a surface appear to come from behind the surface because our vision follows the Law of Reflection. We perceive the object to come from “behind” the surface at a distance equal to the distance between the actual object and the reflective surface.
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## Setup Instructions

1. Clean the PepperGram Projector of any fingerprints
2. Fold the PepperGram into a pyramid and snap the tab to hold the projector together.
3. Search YouTube for any “4 Faces Hologram Videos” on the mobile device.
    a. Ex: https://www.youtube.com/watch?v=4w0q_28g-7k
4. Turn up the brightness on the device and mute video if there is sound
5. Center the projector in the center of the screen and set up cover to provide darkness

## Instructional Procedure

1. Play the 4 Faces Hologram Video from YouTube.
2. Have students look at the hologram from eye level.

## Tips & Tricks

- Find a darker area or partially cover the projector to enhance the viewing.
- If you can find a high-top table for this demonstration, it may make looking at the hologram at eye-level easier for students.

## Careers & Real-World Applications

- **Data Storage:** Holograms, given their 3D nature, increase the capacity of electronic storage devices (ex. CD/DVDs)
- **Advertising:** Automakers used to use cylindrical holograms in the 1970's to depict a new car model, giving a 3D view of the car design. They are still used on books, magazines, and in other 2D mediums.
- **Security:** Holograms are expensive, so many credit card companies use holographic images to authenticate their cards and reduce counterfeiting.
- Careers
    - Cybersecurity Specialist
    - Software Engineer
    - Optical Engineer

## Assessment Questions

1. What is a hologram?
    a. A hologram is a type of photograph that captures light from multiple surfaces of an object so that the image appears to be three-dimensional.
2. What are the types of light interference?
    a. Constructive and destructive interference.
3. What is a standing wave?
    a. A wave pattern that appears still or non-moving because it is constant (ex. Like a river; appears constant, although the water is flowing).

## Clean Up

- Turn device off and return it to the IT bin.
- Store hologram pyramid projector back in its bin.

## References


- http://store.laserclassroom.com/peppergram-projector-for-phone/
- https://www.livescience.com/34652-hologram.html
- http://www.holography.ru/histeng.htm
- http://holocenter.org/what-is-holography
- http://www.scienceclarified.com/He-In/Hologram-and-Holography.html

## Related Next Generation Science Standards

- K-5
    - 4-PS4 Waves and Their Applications in Technologies for Information Transfer
- 6-8
    - MS-PS4 Waves and Their Applications in Technologies for Information Transfer
    - MS-LS1 From Molecules to Organisms: Structure and Processes
- 9-12
    - Waves and Their Applications in Technologies for Information Transfer