

## HOW DO YOU STAGE A HOLOGRAPHIC CONCERT?

Read the article about the science of holographic illusions:

<https://education.australiascience.tv/how-do-you-stage-a-holographic-concert>

In this we learn about the behaviour of light and how ray optics are used in image formation from lenses and mirrors.



### Activity.

This article explained the science of using light to create a holographic illusion.

In this lesson you will explore the reflection of light, specifically specular reflection – when light reflects at the same angle as it hits a surface.

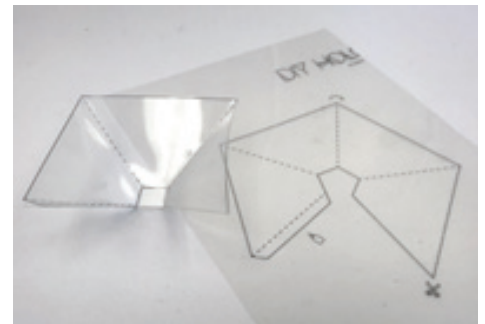
In this activity, you will construct a pyramid projector that creates a reflected image from a digital screen display, your mobile phone! This activity is a modern take on an illusion first described in 1584 by Neapolitan scientist Giambattista della Porta and popularised for theatrical use by John Henry Pepper in the 1860s, hence its modern nickname “Pepper’s Ghost”.

### Apparatus.

- A flat, hard (but flexible) piece of clear plastic, such as recycled packaging or overhead projector (acetate) sheet.
- Scissors or a utility/craft knife (adult supervision required)
- A washable marker
- Clear sticky tape
- Haunted 'Hologram' template <https://www.ontariosciencecentre.ca/media/2326/hauntedholotemplate.jpg>
- A smartphone or tablet with access to YouTube

### Method.

1. Carefully trace the template onto a piece of clear plastic (from packaging in your recycling) or your teacher can provide you with a template already printed on a sheet of transparency/acetate.
2. Cut along the solid lines, take care to cut these lines as straight and even as possible.
3. Fold along the dotted lines, tape together with clear sticky tape. This will form an upside-down pyramid. **The edges of the plastic will probably be sharp, so be sure to take extra care with this step.** This is your projection pyramid!



Check out this simple How-to Video: <https://youtu.be/VRljGNLYMY>

4. On your phone or tablet, open YouTube and visit the following site: <https://youtu.be/OdA77IVRbm0>
5. Select the Pepper's Ghost video, then place your projection pyramid in the middle of your screen with the narrow end facing down, flush with the screen. **If needed, trim the narrow (bottom) end of your pyramid so it sits upright on a flat surface**

Dim the lights in the room and look through the side of the pyramid! **Top – Tip: Turn the brightness to the maximum on your phone or tablet settings. This also works best in a darkened room.**

Click on the links below to experiment with different hologram videos:

Butterfly <https://www.youtube.com/watch?v=vTufphdowOw>

Space <https://www.youtube.com/watch?v=kUERqqY3pdk>

Various 01 <https://www.youtube.com/watch?v=e5W0GLGd1hc>

Various 02 <https://www.youtube.com/watch?v=nQs6gmY286k>

**What did you observe?**

The image you see is a Pepper's Ghost illusion. Use the space below to construct a summary of the observations you made. E.g Can you identify the location of the 'real' image and the 'virtual' image in your display.

- Draw a ray diagram to show your understanding of the science behind the experiment.

**Evaluation**

What surprised you most about the experiment?

Is this illusion a true hologram? Explain your answer.

## The Theory.

Scientist Giambattista della Porta first described the Pepper's Ghost illusion in 1584. Around 1862, the illusion was popularised by inventor and engineer Henry Dirck's and chemist John Henry Pepper.

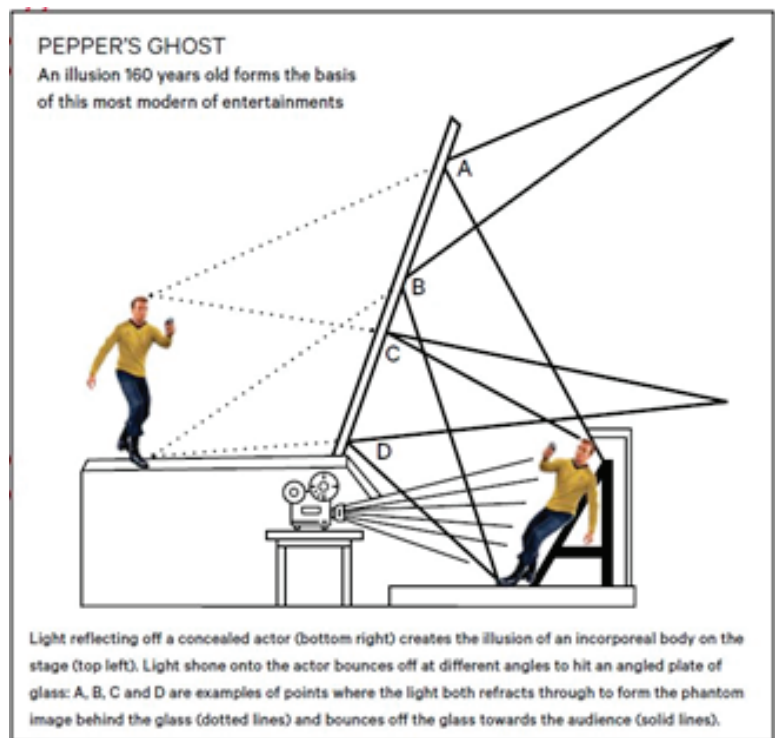
Despite its appearance, the Pepper's Ghost illusion is **not** a hologram. A true hologram is a three-dimensional image created by lasers without the use of lenses, while Pepper's Ghost is an **optical illusion** produced by **reflected** light. The ghostly projection appears when an image is **reflected** against a screen at a 45-degree angle, resulting in a virtual image that appears to have depth and float in mid-air.

The illusion is a common special effect technique that you've probably seen used in theatre's, amusement parks (Disneyland's Haunted Mansion ride is still using this effect over 150 years later), concerts (2012 Coachella Music Festival, where it was used to project a performance by the late American rapper Tupac Shakur), and museums.

The illusion is made possible with glass (or glass-like surfaces such as a transparency) and light. Due to ray optics, light is reflected and refracted to produce an image that appears like a hologram.

This Pepper's Ghost activity, while not a true hologram, takes much less technology and is a good exploration of light and viewing angles.

Real Holograms are 3D images created by interference of light beams. They should be able to be viewed from any angle and allow the viewer to see the object from multiple sides. Real holograms can be seen without the need for special lenses, screens, or other props.



**Want more?**

What is it about the projection pyramid that makes the illusion work? Try changing some **variables** (e.g., shape, number of sides, construction material, type of video...) and comparing results.

- Try creating a new projection pyramid, this time with different dimensions.
- Change the angle of reflection. You can do this by trimming the sides of your pyramid. What happens to the projected image?
- Repeat your experiment using different materials e.g. thicker plastic/acetate. What observations can you make?

There are lots of ways to have fun with your projector and Pepper's Ghost illusion! You can:

- If you're looking for a fun challenge, you can even create your own image or video to use with your projection pyramid! Click the link to find out more: <https://theartofeducation.edu/2018/05/25/a-step-by-step-guide-to-creating-holograms-in-your-classroom/>
- Investigate a different type of optical illusion. Demonstrate and explain it to your classmates. What does it teach us about our eyes and/or our brains?
- A Pepper's Ghost illusion is improperly described as being a 'hologram' by many online sources. What would you call it instead? Conduct your own research to learn more about actual holograms. Create a table of comparison to show your findings.