PEPPER'S GHOST

Think about the last time you stood in front of a window at night, while the lights in your room were on. What did you see?

What Is Pepper's Ghost?

By reflecting a real person against a pane of glass, one can create the image of a ghost floating in "mid-air". This is called Pepper's Ghost, and it's been around for ages!

History of Pepper's Ghost

Pepper's Ghost was first mentioned over 400 years ago, but not demonstrated until an inventor named Henry Dircks created the Dircksian Phantasmagoria in 1862. This was a device that theaters could use to make ghosts appear and disappear on stage at a moment's notice. Sadly, it was a complicated trick that required theatres to be completely rebuilt.

When a professor named John Pepper realized that the illusion could be more simply created, the Pepper's Ghost that we know today was developed. Pepper first showed off the new trick during a performance of Charles Dickens' *A Haunted Man*. The illusion was such a huge success that it was nicknamed Pepper's Ghost, instead of after its original inventor Dircks.

Pepper's Ghost has since been used in theatrical productions, magic shows and haunted houses - and is still in use today!

Reflection and Virtual Images

When you look at yourself in the mirror, your reflection is called a **virtual image**. When something is virtual, it appears to be real, but isn't actually - your reflection looks just like you, standing in front of you, but you're not really there! Virtual images created by plane mirrors, or flat mirrors, follow very strict rules. These virtual images are always as far from the mirror as the real object being reflected, and horizontally inverted - left and right are swapped around. They're also the same size as the original object!

Big Idea

Demonstrate the formation and properties of virtual images by creating a Pepper's Ghost with the Reflect View.

What You'll Need

- 1 Reflect View
- 1 White Lazr finger
- A printed picture with a black background
- A smartphone

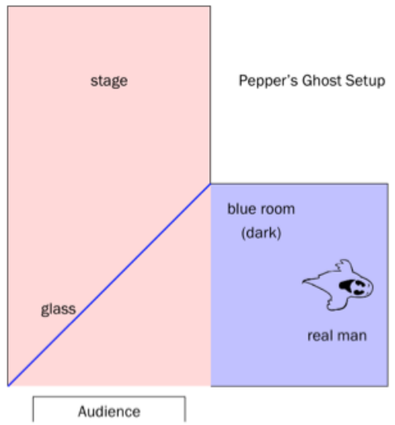

Figure 1: Setup of Pepper's Ghost

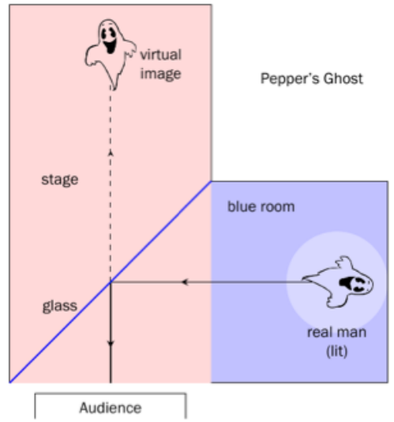

Figure 2: Pepper's Ghost in Action

How Pepper's Ghost Works

One of the ways that **Pepper's Ghost** was created was with a special stage, shown in Figure 1. The stage consisted of two parts: the visible stage (in pink), and a room to one side, hidden from the audience's view (in blue). The hidden room was called the "blue room", and this is where the person dressed as a ghost would stand. The blue room was painted a dark color; usually black.

A sheet of glass was placed at a 45° angle between the stage and blue room. When the blue room was dark and the stage well-lit, the stage seemed empty - think about when you stand in front of a window when it's sunny outside. Can you see your reflection? No, only the objects outside!

Then, when the stage lights were dimmed and a spotlight lit over the man in the blue room, his reflection became visible in the glass. Since the audience couldn't see the real man, it appeared as though a ghost was floating on the stage!

Pepper's Ghost in Real Life: Disneyland's Haunted Mansion

The ballroom of Disneyland's Haunted Mansion is one of the largest examples of Pepper's Ghost in action. As guests travel through the haunted room, they're actually looking down into an empty ballroom covered by a gigantic sheet of glass.

Hidden from the guests' view, robotic "ghosts" dance and dine in a black recreation of the ballroom. As they're lit in the fake ballroom, they appear dancing in the real ballroom, and disappear just as quickly when they move away from the lights.

ACTIVITY SHEET

Pepper's Ghost

We're now going to create an old-fashioned Pepper's Ghost. For these activities, you'll want to darken the room you're working in as much as possible - the darker the room, the clearer the images!

1. Place the printed picture on a flat surface. The surface should either be at eye level, or you should be able to crouch down so that it is.
2. Hold the Reflect View over the picture at a slant. Rest the top end of the Reflect View on the table just below the picture. Make sure the bevelled (stepped) edge of the Reflect View is facing towards you.
3. Shine the Lazr finger onto the picture. Hold it about 10-20 cm from the picture, and be careful not to shine the light through the Reflect View. You want to get as little glare as possible on the picture.
4. Look directly into the Reflect View. You should be low enough that you don't see the picture on the table.

What do you see? Think about how far the virtual image of the picture appears behind the Reflect View, and how it compares to the original picture.

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You should notice that the virtual image appears to be the same distance from the Reflect View as the original picture. The virtual image is also inverted, or swapped around.

5. Replace the picture and Lazr finger with a video played on the smartphone. Something like a candle with a black background works best.

What do you see now? Is it different to when you used the printed picture?

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This proves what we know about virtual images - the candle floats the same distance behind the Reflect View as the smartphone, and it's swapped around!

What could you do to make the candle appear further away than it does now? Use what you know about virtual images!

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To move a virtual image further away from the reflective surface, you need to move the object being reflected. We could do that by moving the Reflect View further from the smartphone, or making the Reflect View bigger and using a bigger screen!