Miracle Mirror

92-7170

INSTRUCTIONAL GUIDE

Contents

Miracle Mirror

- 14 cm dia. Hemispherical mirror
  - Convex and concave sides are reflective

Recommended for Activity:

- Pencil
- Length of cardboard
- Flashlight

Introduction

A plastic hemisphere is coated with aluminum to create a concave mirror on the inside and a convex mirror on the outside, permitting a variety of fascinating experiments on the differences between the two types of reflecting surfaces. The life-like image projected from the concave side is particularly dramatic and unexpected. It appears as though the reflected image (of a finger, for example) is popping right out of the mirror!

Background

Reflected images from the concave mirror

When viewing images from the concave side of the mirror, it will appear as thought the central part of the mirror is well-polished, while the surrounding portions are not as reflective. Place the tip of a pencil on the edge of the mirror ("A" in Fig. 1) and observe the resulting reflection. Note that not one but three distinct reflected images are formed. (A1, A2, and A3 in the figure).

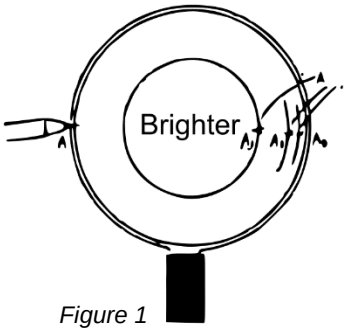

Figure 1

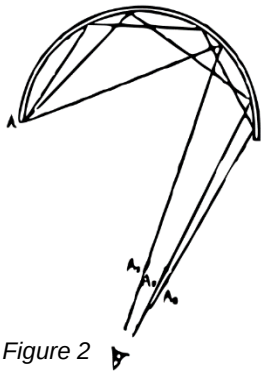

Figure 2

This effect is based on the fact that A1 represents a single reflection of light rays from the surface of the mirror. A2 is a double reflection and A3 is a triple reflection light within the interior of the mirror (see Fig. 2).

When the tip of the pencil breaks the surface defined by the edge of the hemisphere, image A1 represents a single reflection from the brighter, central portion of the hemisphere. In effect, the edge of the hemisphere is a border between the brighter and darker portions of the interior. In fact, the image projected from the center of the hemisphere appears brighter since it represents only a single reflection of light.

Focal point of the concave mirror

The focal point of the concave mirror is at the center of the hemisphere, as shown in Fig. 3. Therefore, when the concave surface faces the sun and a piece of paper is placed at the focal point, the paper will burn.

Some of the rays emerging from point A in the diagram are reflected from the surface of the concave mirror and concentrated at point B, and thus when an object such as a finger is inserted into the concave mirror, the life-like reflected image appears to pop out (Fig. 4)

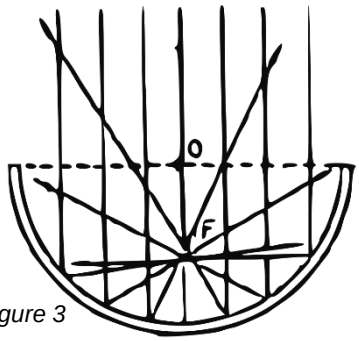

Figure 3

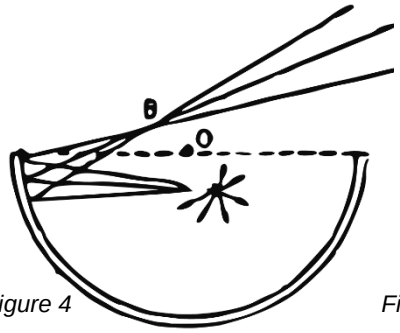

Figure 4

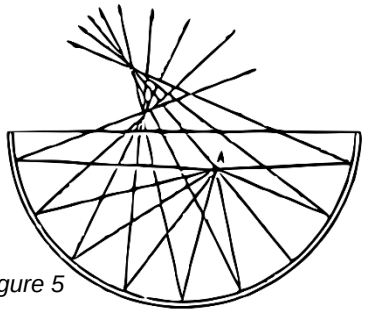

Figure 5

Parallel rays entering the interior of the hemisphere are not completely concentrated at one point, and thus strictly speaking, there is no focal point under this condition, although the rays are concentrated within rather narrow range.

Reflected rays emerging from the interior of the hemisphere from point A scatter across a wide area, as shown in Fig. 5 and are not concentrated at a single point. However, at a given sighting position, the rays which enter the eye have not been so widely scattered, having first concentrated at point B.

Activities

1. Observing life-like images: When an object, such as a finger, is inserted into the interior of the hemisphere, the reflected image seems to pop out with a dramatically life-like appearance.

2. Experiment for projecting a life-like image: Attach a pea approximately 20cm from the edge of a sheet of cardboard. Turn the cardboard upside down and bring it close to the Miracle Mirror. The reflected image of the pea will appear to float inside the mirror, and while it appears to be life-like, it cannot be grasped.

3. Illuminating the life-like reflection: To distinguish the real object from the life-like reflection, direct the beam of a flashlight (which projects parallel light rays) onto the reflected image created in Activity 2. The shadow of the real pea will appear.

4. Reflected sunlight will cause a piece of paper to burn at the focal point of the concave mirror. A cigarette can be lit in the same way.

5. As you bring your hand near the mirror, the reflected image is dramatically distorted, with the closer portion of the hand appearing larger than the more distant portion.

6. When the concave mirror is 70~80% filled with water, a swaying ball appears. When you place your finger into the water, the reflected image seems to jump out of the water. (The effect is best when you place your finger slightly off the center of the hemisphere.)

Related Products

Introductory Optical System (92-7700) This simple but elegant Optical System is designed for basic optics experiments, and a great alternative to the traditional mounted optical benches. Students can now easily make the common measurements of image and focal distance with the included lenses, pinhole configurations, and 2-sided screen.

Pair of Mega Mirrors (P2-7150) These extra-large parabolic mirrors make dramatic demonstrations of optical principles a snap. Each aluminized mirror measures 24" in diameter and is supplied with an aluminum frame, mounting bracket, and base.

Hand Held Concave/Convex Mirror (P2-7144) Concave on one side, convex on the other. This versatile 75mm diameter mirror has a focal length of 20cm, great for arm's-length explorations.