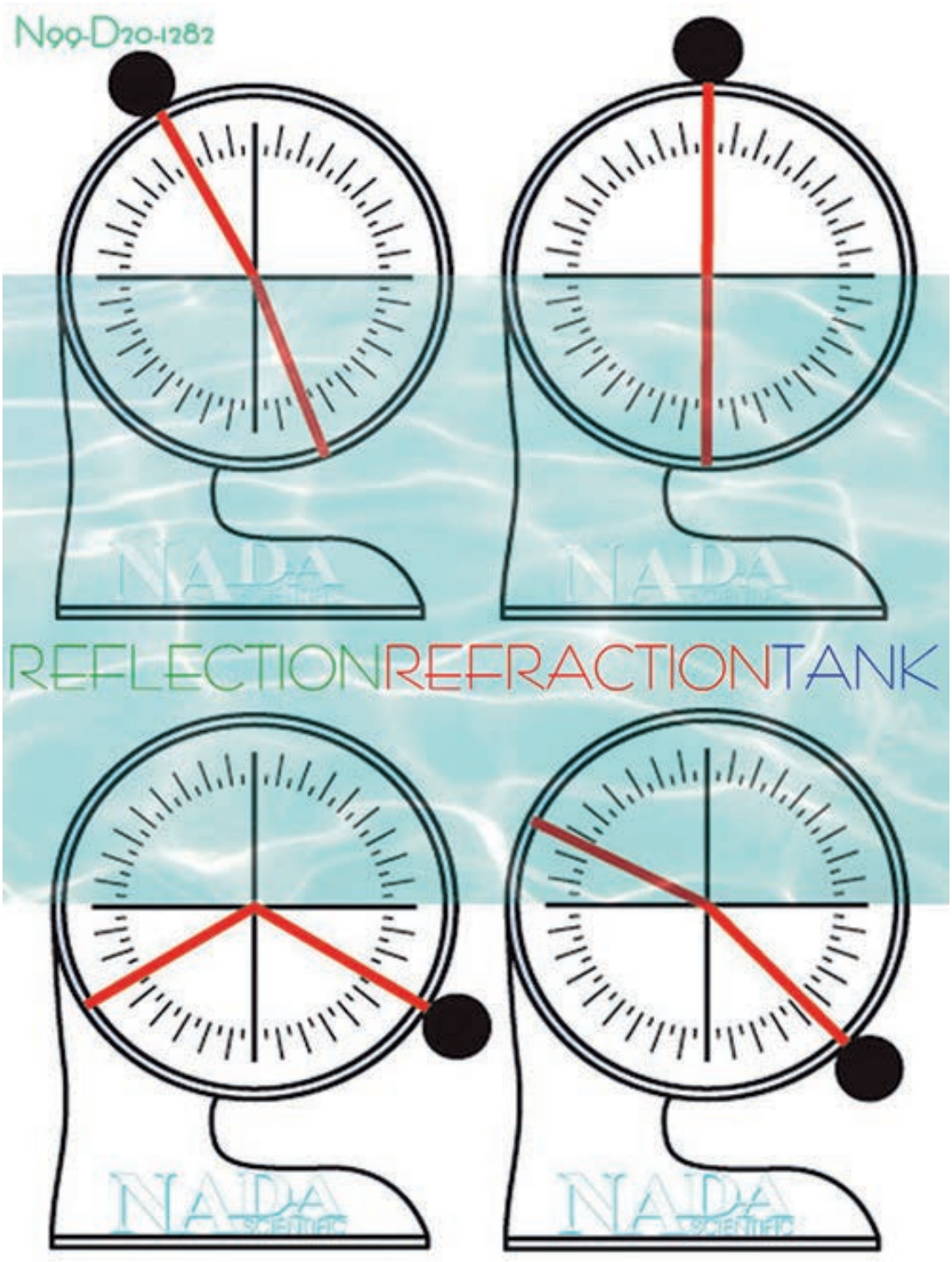
REFLECTION REFRACTION TANK

N99-D20-1282



Manual of Operations

IMPORTANT!

Read the following before using this equipment:

Carefully follow all instructions and observe all precautions given in this manual

Purpose

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.

Specifications

Miracle Mirror: Plastic, coated with aluminum; 14cm in diameter
Stand: Iron (melamine-coated steel)

1. **Reflected images from the concave mirror.** When viewing images from the front (concave side) of the mirror, it will appear as though the central half of the mirror is well polished, while the surrounding portions are not so well polished. 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).
This effect is due to 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, 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, while closer to the periphery appear less bright since the light has entered at a greater angle, resulting in multiple reflections within the mirror. In other words, the relative brightness of different portions of the mirror's interior surface is not a function of the mirror itself, but of the relative strength of the light rays exiting the interior of the mirror. To prove this relationship, simply slant the mirror to observe the shift of the brighter portion.

Caution: Sunlight is focused by the concave mirror surface, therefore do not leave the mirror under sunshine. Handle the mirror carefully, since the aluminum-coated surface may become scratched.

2. **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 lifelike reflected image appears to pop out (Fig. 4).
The 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 a rather narrow range. Reflected rays that emerge from the interior of the hemisphere near 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.

Experimental observations

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 dramatical 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.
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.