Experiment Instruction Manual

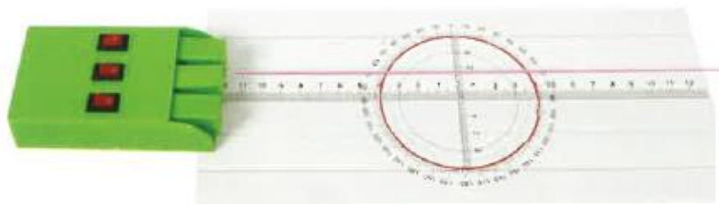
[English version manual]

Compulsory Education Textbook Experimental Support Kit

Experimental Topic 1: Light Propagation in a Straight Line

1. Experiment: Linear Propagation of Light

- Turn on one beam of a three-line laser source and direct it onto white paper or a white wall. You'll observe that the light travels in a straight line, as shown in the figure.



2. Formation of Shadows

- Because light travels in a straight line, when it hits an opaque object, it creates a shadow behind the object. This shadow demonstrates the straight-line propagation of light. Celestial events like solar and lunar eclipses occur due to the shadows cast by the Earth and the Moon.

3. Experiment: Pinhole Imaging

- Method: In a dark environment, set up a light source (such as a candle), a board with a small hole, and a white screen on a horizontal table. Align the candle flame, the hole, and the fields of view on the white screen to the same height. Adjust the distances between them to observe the image on the screen. Note the size, distance, and orientation of the image.

- **Experimental Principle:** The phenomenon of pinhole imaging is caused by the linear propagation of light.

Pinhole Imaging

- **Characteristics of Pinhole Imaging:** Pinhole imaging produces an inverted real image.

Questions to Think About:

1. What are the conditions for light to travel in a straight line?
2. What is a real image? What is the principle of pinhole imaging? What are the characteristics of pinhole imaging?

Experimental Topic 2 - Reflection of Light:

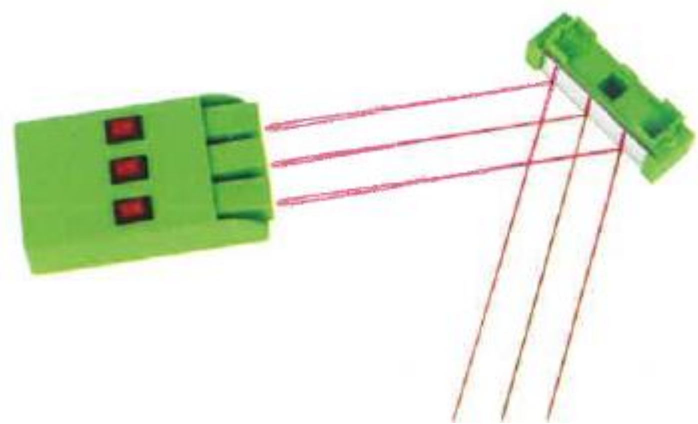
1.Explore the Imaging Rules of Plane Mirrors:

Insert the small rectangular plane mirror (remove the protective film if using it for the first time) into the plastic slider, then place it on the dial paper. Use a three-line laser light source, turn it on to emit a laser beam, and change the incident angles. Observe the reflection of light and summarize the law of light reflection.

Questions to Think About:

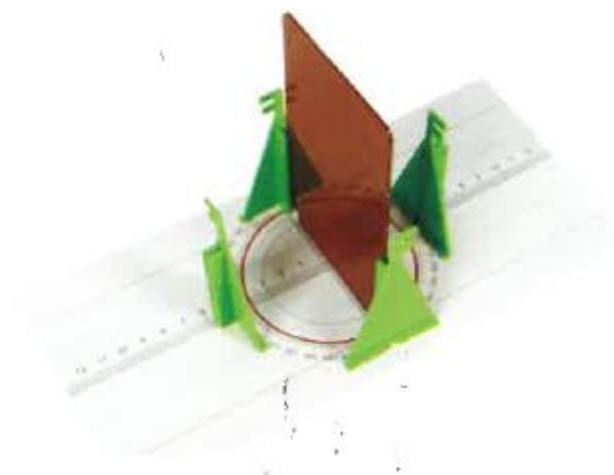
1. From the experiment, identify what is incident light, the incident angle, reflected light, the reflector, and the normal.

2. Summarize the law of reflection of light.



2.Explore the Imaging Rules of Plane Mirrors:

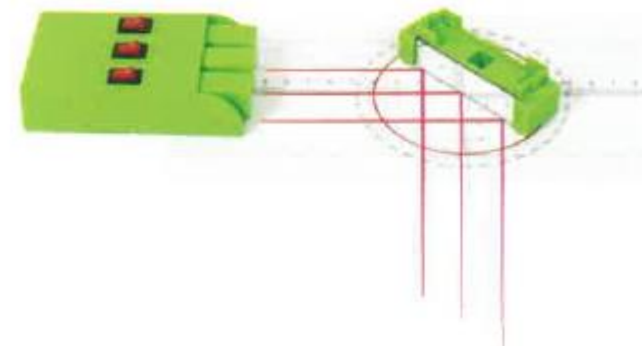
On a piece of A4 white paper, place the black, brown mirror panel (acting as a plane mirror) on the bracket. Then, take one of the "F" brackets and place it in front of the black, brown mirror panel. Observe the image in the mirror. Use another "F" bracket and place it behind the dark brown mirror. Align the "F" completely with the image in the mirror. Then use a pencil to mark the line in front of the mirror panel and the positions of the two "F" brackets in front and behind the mirror. Connect the lines and measure the distances.



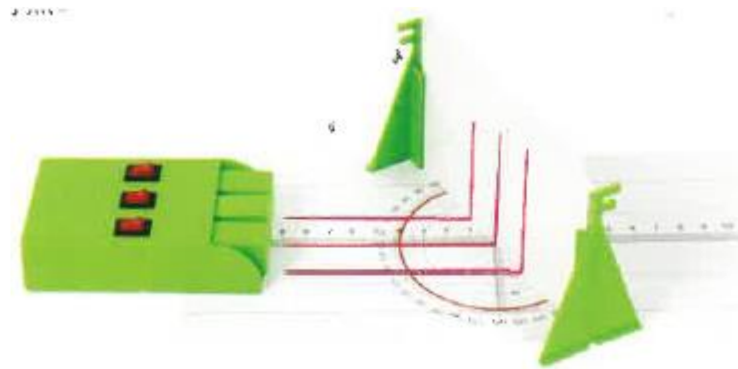
Question: Through experiments and measurements, summarize the characteristics of plane mirror imaging. Is plane mirror imaging a virtual image or a real image?

3. Specular Reflection and Diffuse Reflection:

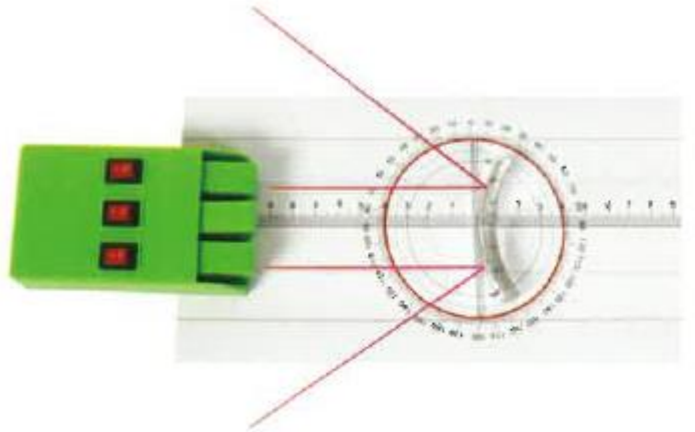
1. Specular Reflection: Adjust the distance and angle of the three source heads of the three-line laser light source so that the three laser beams emitted are parallel. Then, direct the beams onto the small plane mirror. The reflected beams should also be parallel. This phenomenon is called specular reflection.



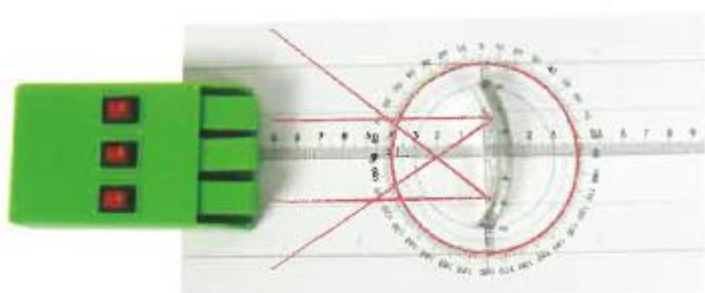
(2) Diffuse Reflection:
As shown below, when three strong beams of light emitted by the three-line laser light source are directed onto a frosted surface, the reflected light is scattered and soft. Compared to the specular reflection described earlier, this illustrates the characteristics of diffuse reflection:



(3) Reflection of Light by a Convex Mirror:
(Details and observations about the reflection of light by a convex mirror should be placed here.)



(4) Reflection of Light by a Concave Mirror:
As shown below, use a concave mirror (be sure to remove the protective film if using it for the first time) and a three-line laser light source to explore how the concave mirror affects light.



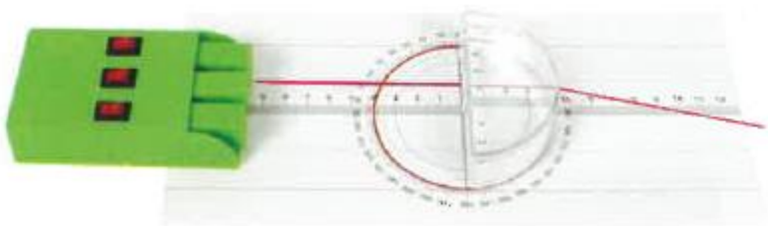
Questions to Think About:
Through the above experiments, what characteristics does a concave mirror have regarding light? Summarize the following:

- What is the focus of a concave mirror?
- What is the focal length of a concave mirror?
- Why is the focus of a concave mirror considering a real focus?
- What practical uses does this characteristic have?

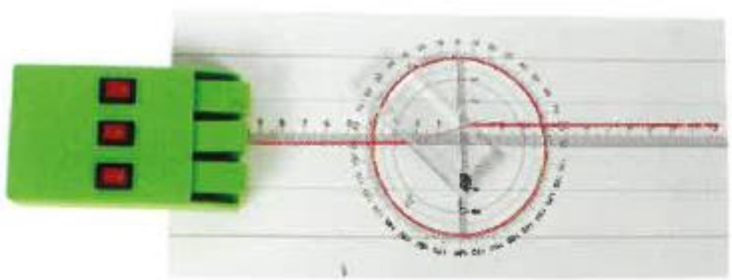
Experimental Topic Three: Refraction of Light

When light is incident obliquely from one medium into another, the direction of propagation changes, causing the light to bend at the junction between the two media. Both refraction and reflection of light occur at the boundary between two media. However, reflected light returns to the original medium, while refracted light enters the new medium. Since light travels at different speeds in different materials, its propagation direction changes at the interface between the two media. In refraction, the light path is reversible.

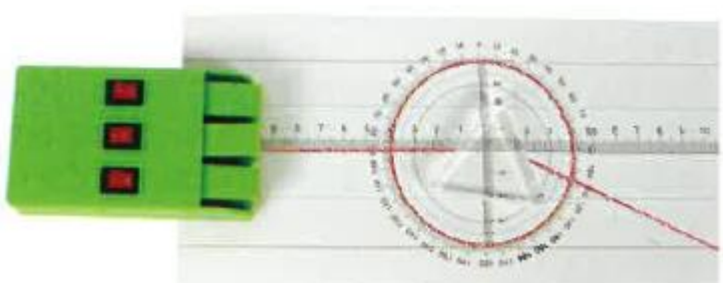
Light Refraction Demonstration (Optional):
When three parallel light beams pass through an empty convex water cup, they remain parallel. However, after adding water to the cup, you will observe that the light rays converge, demonstrating that light is refracted in the water, which alters its path.



1. Explore the Laws of Refraction of Light:



2. Refraction of Light Through a Prism:



3. Refraction of Light Through Air and Water:
Use the laser light source provided in the equipment and a small water tank. Fill the tank with water up to two-thirds of its volume. Shine the laser beam diagonally from the air into the water and observe the change in the propagation direction of the light.

4. Refraction of Light Through Glass Bricks:

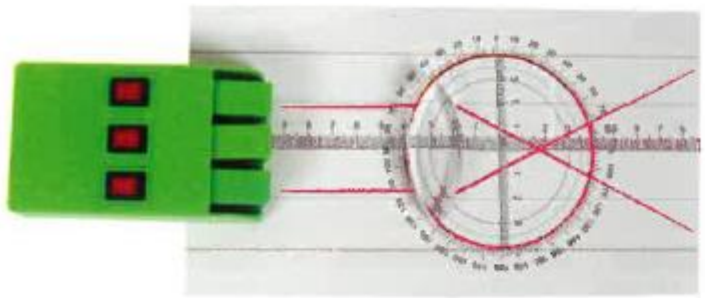
Questions to Think About:

1. Identify what refracted rays, normal, and refraction angles are.
2. Summarize what happens when light enters substances like glass or water from air. How does the direction of light propagation change?
3. Summarize the rules governing the direction of light propagation when it enters air from other media.

Experimental Topic Four — Lenses

1. Understanding Convex Lenses:
Through observation, we find that a convex lens is thicker in the middle and thinner at the edges. What effect does this type of lens have on light?

2. The Effect of a Convex Lens on Light:
To facilitate research, in the experiment shown below, we use a lens with the shape of the longitudinal section of the optical center of a convex lens. This lens is a cylindrical convex lens, which makes it easier to observe the effect of the convex lens on light.



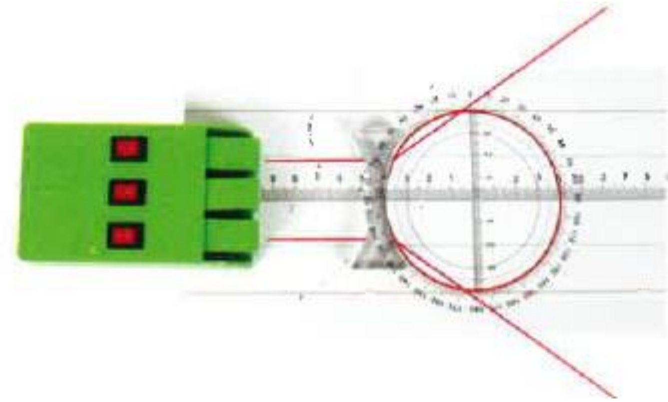
Through experimental observation, we will find that convex lenses have a converging effect on light.

Questions to Think About:
Through this experiment, summarize the following:

- What is the focus of a convex lens?
- What is the focal length of a convex lens?
- Why is the focus of a convex lens considering a real focus?

3. Understanding Concave Lenses:
A concave lens is a lens that is thinner in the middle and thicker at the edges.

4. The Effect of a Concave Lens on Light:
Using the same principle as the convex lens experiment, we study the effect of a concave lens on light by using a cylindrical concave lens, which is the shape of the central cross-section of a concave lens.



Through experimental observation, we find that concave lenses have a divergent effect on light.

(1) Explore the Imaging Rules of Convex Lenses:
Convex lens imaging is a key part of optical experiments. Through convex lens imaging experiments, we can understand the principle of Optical Instruments (Cameras, Movie Projectors, and Magnifying Glasses). To make the convex lens experiment more convenient, the equipment uses a newly designed F-shaped light source as the imaging object, combined with a 7.5cm

short focal length convex lens. The setup is as follows (using a dedicated F-shaped light source instead of candles):

In the experiments described below, the distance between the candle or "F" light source and the convex lens is referred to as the "object distance (u)," and the distance between the clear image on the imaging screen and the convex lens is called the "image distance (v)."

Experimental Steps:

1. **Imaging When the Object Distance is Greater Than Twice the Focal Length (u > 2f):**
   Adjust the object distance to be greater than twice the focal length. Observe the size, orientation, and image distance of the image formed by the convex lens.

2. **Imaging When the Object Distance is Equal to Twice the Focal Length (u = 2f):**
   Adjust the object distance to be equal to twice the focal length. Observe the size, orientation, and image distance of the image formed by the convex lens.

3. **Imaging When the Object Distance is Greater Than the Focal Length but Less Than Twice the Focal Length (f < u < 2f):**
   Adjust the object distance to be greater than the focal length but less than twice the focal length. Observe the size, orientation, and image distance of the image formed by the convex lens.

4. **Imaging When the Object Distance is Smaller Than the Focal Length (u < f):**
   Place the candle or F-shaped light source within the focal length of the convex lens. Observe whether a clear image forms on the imaging screen. Then, move the imaging screen and look through the lens to see if an image appears on the same side as the object.

(2) Explore the Imaging Rules of Concave Lenses:

1. **Imaging with Concave Lenses:**
   After exploring the imaging characteristics of convex lenses, we now study whether concave lenses can produce images. If they can, what are the characteristics of these images?

Experimental Method: Refer to the convex lens imaging method, using candles or F-shaped light sources. First, determine whether a real image can form on the imaging screen. If not, observe the object through the concave lens and note any changes.