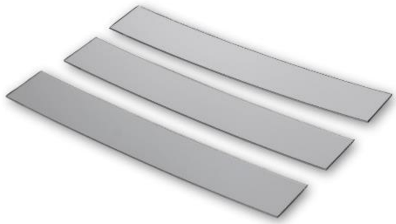
Reflection & Refraction Discovery Bundle

P2-1235

Contents


Convex/Concave Mirror

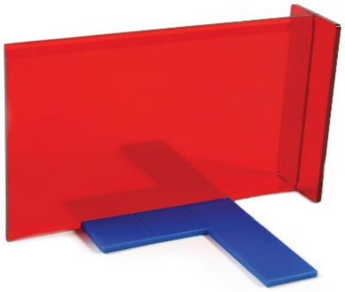

Plastic Mirror 1.625” x 9” 3 Pack

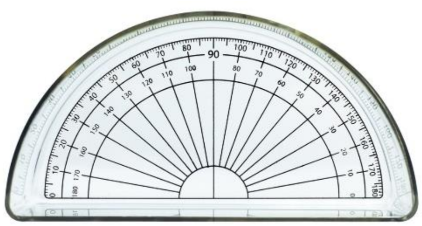

Phantom Crystals


Convex/Concave Mirror Set


Right Angle Prism

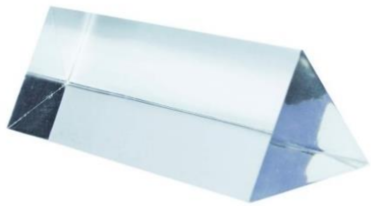

3D Mirascope Illusion Maker


Reflect-View


Refraction Cup with Printed Angles


Concave Convex Lens Set


Periscope


Equilateral Glass Prism

Item	Topic	Instructions
Convex/Concave Mirror (P2-7144)	Reflection Image formation Convex mirrors Concave mirrors	Hold the mirror at arm's length, looking at the concave side. Observe your image. Move the mirror closer to you, and observe how the image changes as the mirror comes closer. Can you identify the focal length? Repeat with the convex side.
Mirror, Plastic 1.625" x 9" 3 Pack (P2-7143)	Reflection Image formation	Arrange the three mirrors in a triangle and place them inside a standard 2" mailing tube. Look through the tube for a kaleidoscopic view. Discuss the multiple images seen in the mirrors.
Phantom Crystals (P6-2800)	Refraction Index of refraction	Instructional Guide Included
Convex/Concave Mirror Set (P2-7145)	Reflection Image formation Convex mirrors Concave mirrors Focal length	View your image in each mirror. Is it large? Small? Inverted? Focus light to measure the focal lengths of the converging mirrors. Challenge students to find the focal lengths of the diverging mirrors.
Right Angle Prism (33-0225)	Refraction Dispersion	Shine a laser beam through each surface of the prism, at different angles. Observe how the prism causes light to bend. If possible, shine a different colored laser through the prism and observe the difference in the amount of refraction. Place the prism near a bright source of white light (or in a bright sunbeam) and observe the light that emerges.
3D Mirascope Illusion Maker (P2-7040)	Reflection Real image formation	The Mirascope demonstrates a 3-dimensional *real* image. Put any small object into the Mirascope and watch with amazement as its image seems to hover above the opening.
Reflect-View (P2-9570)	Reflection Transmission Plane mirror optics	See attached activities from the *Light and Color Teacher's Guide (P2-9560).*
Refraction Cup with Printed Angles (P2-1225)	Refraction Index of refraction	Fill the cup with different liquids to observe their effect on angles of refraction. A convenient way to measure the angle of refraction is to shine a beam of light into the center of the straight side and measure the angle that it exits the other side. (The beam will not refract again at the curved side this way, as it will always be incident perpendicular to the surface.)
Concave Convex Lens Set (P2-1200)	Refraction Convex (converging) lenses Concave (diverging) lenses Image formation	View objects through each lens to see how the images form. Are they larger? Smaller? Inverted? Focus light to measure the focal lengths of the converging lenses. Challenge students to find the focal lengths of the diverging lenses. (They must combine them with converging lenses and focus light with the combination.)
Periscope (P2-7080)	Plane mirror reflection Image formation	Instructional Guide Included
Equilateral Glass Prism (33-0220)	Refraction Dispersion	Equilateral prisms are ideal for wavelength separation. Shine white light through one of the corners and watch as a spectrum appears. Show students how wavelengths refract differently by shining two different-color lasers through the prism.

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.

Laser Ray Box and Lenses (P2-7680) Complete Optics Set uses 1, 3, or 5 Laser Beams! The most complete, economical optics kit you'll find!

Light Box and Optical Set 2.0 (P2-9580) This affordable Light Box and Optical Set makes it easy to perform experiments involving the optics of lenses, mirrors, and prisms, as well as providing a versatile way to display primary and secondary colors; and both additive and subtractive color mixing.

Phantom Crystals

P6-2800

INSTRUCTIONAL GUIDE

Contents

- 1 vial containing 25g of Phantom Crystals

Recommended for activity:
- Petri dish (PX-2076)

Background

Light travels at slightly different speeds through different substances. As light waves pass from one transparent substance into another, the waves slow down or speed up and, as a result, refract. Refraction means that the light is pointed in a new direction. The angle at which the light is redirected is called the “angle of refraction.” The angle of refraction is different for each substance and is slightly different for each frequency of light. This is how a prism breaks up white light into a rainbow. The directions of the different colors (different frequencies) are changed due to refraction. Since each color is refracted at different angles, the output is a spread-out display of all the colors that made up the original light.

Refraction is also responsible for the common “broken pencil” illusion. A pencil, partly submerged in water, appears to be broken at the water’s surface. The light from the pencil (the pencil’s image) gets slowed down and refracted as it passes from the water to the glass. It is refracted again (in the other direction) as it passes from the glass to the water. This returns the original angle of the light, but the pencil has been shifted slightly to the side. In fact, the whole background seems “off a bit.”

A ratio, called the “index of refraction,” is used by physicists to describe how much refraction takes place when light travels through one substance into another. Because Phantom Crystals are made up almost entirely of water, they have almost the exact same index of refraction as water. Light will pass from the surrounding water into the crystal without being refracted. Hence, you can’t see it when it is submerged in water. When the crystal is exposed to the air, it instantly becomes visible again. We can see its shape and size because air’s index of refraction is very different than water’s.

Introduction

These carbon-based polymers were designed to be small water-absorbing crystals that may be added to potting soil to help keep plants from drying out.

Phantom Crystals are reported to contain: Non-plantfood Products—25% Hydroxyethel Methacrylate, methacrylic acid, acrylimide copolymer, cross-linked homopolymer for absorption and desorption of water, and 35% silica to stabilize the system.

Set-Up

1. It's a good idea to wash your hands thoroughly before handling the crystals. Oils from your skin can get absorbed onto the crystal and cloud up its surface. Also, try to handle the crystals as little as possible.
2. If bubbles form inside the crystals, try placing the jar in the refrigerator for a few hours to dissolve the excess gas. When the jar is removed and the water warms up, the dissolved gas tends to exit at the water's surface rather than back into the crystals.

Activity

1. Put several Phantom Crystals into a large, clean glass jar and fill it approximately ¾ full with distilled water. Place the lid on and wait a few hours.
2. When the crystals have grown to the point where they appear essentially invisible, pour four or five of them into a clean petri dish. Although they seem to appear like pieces of glass, they are actually quite rubbery.
3. Choose one of the crystals and, touching it as little as possible, attach it to a paper clip.
4. Drop the crystal and paperclip into a clear glass of shallow water. The crystal will seem to disappear.
5. Next, show your students the vial of water with what appears to be a floating or suspended paper clip inside. Let them examine it closely and postulate if it is possible that there may be something in the jar that we cannot see.
6. Lift the paper clip out of the jar and show them the crystal. Put the crystal back in the jar and show them how it disappears as it is submerged in the water.
7. Discuss why we can see the crystal when it is surrounded by air, but cannot when it is surrounded by water.
8. Have the students make predictions of how long it takes the crystals to dehydrate. Try different set-ups:
    a. crystals condensed in glass jar
    b. crystals spread out on a plate

Introduction

Hollow Prism (P2-7020) This equilateral prism has 45mm sides. One end has a hole for adding fluids to study refraction and dispersion. Includes a funnel and stopper.

Refraction Cup with Printed Angles (P2-1225) Fill these semicircular cells with different liquids to observe their refractive properties. Great for showing total internal reflection! Measure angles with the printed protractor.

Laser Refraction Tank (P2-7095) This self-contained unit allows students to measure and study refraction of light.

Reflect-View Excerpt from Light and Color Teacher's Guide (P2-9560):

Where is the Image?

Goal

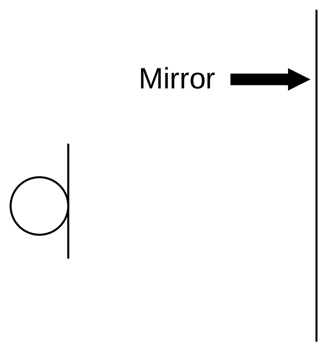
- To find where the image is formed when a plane mirror is used.

Materials

Reflect-View, Centimeter ruler, Coins

Procedure

1. Place the Reflect-View (red mirror) on the mirror line below.
2. Place the edge of a coin on the short line below to the left of the mirror. Look into the red mirror to see the image of the coin.
3. Where does the image appear to be located?
   ____
4. Is the image in front of the mirror or behind the mirror? ______________________________



5. Now place a second identical coin at the location of the image of the coin. Measure the distance from the coin edge near the mirror to the mirror. _______________cm
6. Measure the distance from the mirror to the nearest part of coin's image. _____________ cm
7. How do these distances compare? ____
8. Where was the image located? ____
9. If you were to replace the red mirror with a real mirror where would you expect to see the image of the coin?
   ____
10. Now, replace the red mirror with the mirror from your kit. Where is the image of the coin? What did you find?
    ____

11. Complete the statement: The image formed by a plane mirror will appear ________________ the mirror and the distance the image is from the mirror will be ________________ to the distance the object is from the mirror.

Plane Mirror Images and Objects

Goal

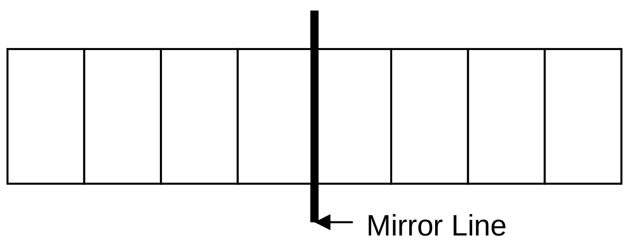
- To find where the image is formed when a plane mirror is used.

Materials

- Reflect-View
- Mirror (From Light Box Optics Kit)
- Ruler

Procedure

1. Neatly print your first name, or just the first four letters of your name, in blocks below, one letter per block. Use capital letters only. Sketch how you think the letters will appear if observed in a mirror.



2. Why do you think the letters will appear as you have sketched them?

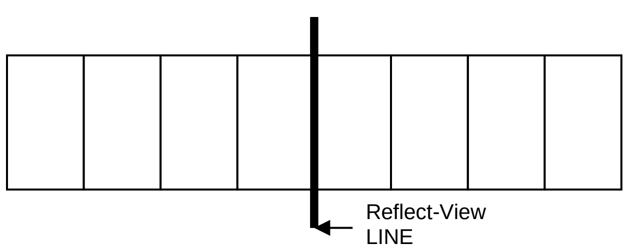
____

____

3. Hold the Reflect-View upright on the line marked "Reflect-View line".

4. Look at the Reflect-View from the same side as you placed the letters.

5. Place your writing hand behind Reflect-View and trace the image of the letters.



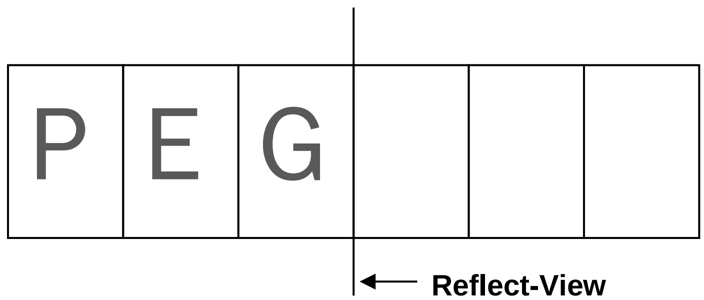
6. DESCRIBE how the traced letters (seen through the Reflect-View) are different from the original printed letters.

____

7. Place a mirror on the mirror line. Check your predictions with the image in the mirror. Compare the image observed in a mirror with the image observed in a Reflect-View.

8. What relationship exists between the distance from object to mirror and the distance from image to mirror?

9. Sketch the image of PEG in the blanks below. Check your sketch with the Reflect-View.



a. How far from the mirror line is the letter P? ______

b. How far from the mirror line is the image of letter P? ______

c. How far from the mirror line is the letter G? ______

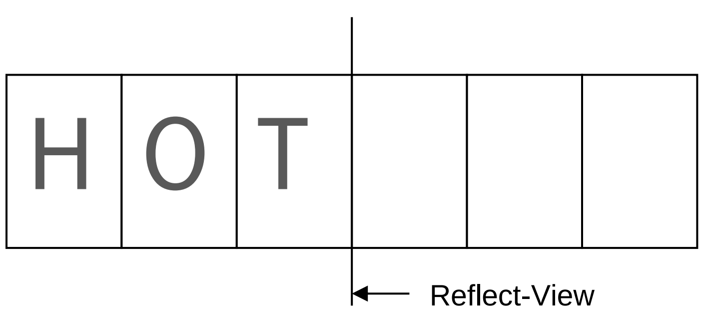
d. How far from the mirror line is the image of letter G? ______

e. Compare the object distance and image distance for the letters P and the G.

10. Contrast the image of the letter P with the letter P.

11. Does the Reflect-View cause a left to right reversal in the image from the object? ____

12. Sketch the image of HOT in the blanks below. Check your sketch with the Reflect-View.



a. How far from the mirror line is the letter H? ______

b. How far from the mirror line is the image of letter H? ______

c. How far from the mirror line is the letter T? ______

d. How far from the mirror line is the image of letter T? ______

e. Compare the object distance and image distance for the letters H and the T.
____

13. Contrast the image of the letter H with the letter H.
____
____

14. Does the Reflect-View cause a left to right reversal in the image from the object? ____

15. Why do some letters like H, O, and T not have left to right reversal?
____
____

Periscope

P2-7080

INSTRUCTIONAL GUIDE

Contents

- Periscope
- Instructional Guide
- Student Worksheet

Teacher Notes

This experiment is appropriate for students at any level. Students should have completed on how light reflects from a plane mirror before completing this lab.

Educational Objectives:

- To use the Internet to find plans for a homemade periscope.
- To construct a periscope.
- To observe the operation of a periscope.
- To diagram the behavior of light in a periscope.
- Extension: To diagram the behavior of light in a modified periscope.

Key Question:

- How does a periscope work?

Concept Overview:

A periscope works by reflecting light rays off of two mirrors to produce an image.

Notice that the image is right-side-up, with the light rays from the top of the tree going to the top of the image (Figure 1). Students are asked to compare this situation with one in which the top mirror is rotated so that it points behind the observer, as in Figure 2.

In this case, an inverted image is formed. For this reason, periscopes in submarines must be allowed to completely turn around. It would not work to just have the top mirror rotate.

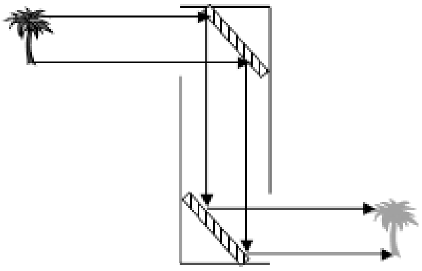


Figure 1

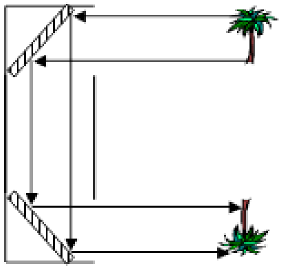


Figure 2

Related Products

Periscope Classroom Kit (P2-7085) A fun and engaging classroom STEM activity that allow 30 students to build and test their own periscope for exploring the law of reflection.

Reflect-View (P2-9570) With this specialized "mirror" your students can easily see the concepts of reflective symmetry, transformations (slides, flips, and rotations), congruence, and constructions in action.

3D Mirascope Illusion Maker (P2-7040) Parabolic mirrors create a floating holographic image that looks 100% real, but try to touch it and your fingers go right through! Create a hologram with any small object.

HOW DOES A PERISCOPE WORK?

Objective: Investigate the operation of a periscope.

Materials: Periscope

Procedure:

1. Draw a diagram of how light rays from an object enter and move through the periscope. Use rays to represent the top and bottom of the object.

2. Periscopes are used in submarines. When the person in the submarine wants to view things in different directions, he walks around moving the whole periscope with him. Since space is at a premium in submarines, why don't they just mechanically turn the top of the periscope, rather than use so much space inside the sub? Try it with your periscope. Rotate only the top portion so that the mirror points in different directions, and record your observations. Draw a diagram showing the operation of a periscope with the top mirror aimed behind the observer. Use this diagram to explain your observations.

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