PERISCOPE

OBJECTIVE:

You will understand the way plain mirrors reflect light rays and will construct and use a periscope to look around or over an object.

INTRODUCTION:

The periscope is an optical instrument that allows the viewer to observe from an indirect, and usually lower, standpoint, such as a hidden or protected position. There are many types, but all consist of a tube with a mirror on either end. The mirrors are parallel to one another but inclined at 45-degree angles. The tube is held upright when used, with the top directed toward the object to be viewed. The upper mirror reflects the object and projects an image of it onto the lower mirror, which is directed toward the viewing port. Some periscopes incorporate magnifying lenses to enlarge the image.

Periscopes have been most widely used in war: for viewing from submerged submarines, from trenches, and, most recently, from armored tanks. The device was invented in 1854 by E. M. Marie-Davy, a French inventor, for use in submarines. Later, it was used in the US Civil War and even more extensively in World War I and II.

Today, periscopes are still used in tanks and submarines. However, they are also used in nonmilitary situations where dangerous substances must be handled or dangerous processes observed, but from a distance so as to protect the viewer, such as by workers handling radioactive material. The world's longest periscope is 90 feet long and is located at the National Reactor Testing Station in Arco, Idaho.

TIME NEEDED:

1 hour

MATERIALS:

large, long box, 2–3 in. x 2–3 in. x 18–39 in. (e.g., empty aluminum foil box)
dark tape (e.g., brown packing tape)
ruler
pencil
X-acto® knife
cutting board
2 square, plastic mirrors about 2 1/2 in. x 3 1/2 in. (available from a hardware store or lab supplier)

Safety Precautions

Please read and copy the safety precautions at the beginning of this book. Be careful when removing the sharp cutting edge of the box and when cutting with the knife.

PROCEDURE:

1. Carefully remove the serrated metal cutting edge of the box. Then use tape to seal the cover of the box.
2. Draw a triangle line at each end of the box on sides A and B by drawing an L with 2-in. sides along the top and one side of the box, and then drawing a line to join the ends. Turn over the box and draw similar triangles on the reverse side (see figure 1).
3. Using an X-acto® knife and working on the cutting board, carefully cut a slot 1 mm wide along each diagonal line. These are the 45-degree slots into which the mirrors will be placed.
4. Mark and cut out two squares on the sides of the box without slots (sides 1 and 2). Be careful to select the correct sides, as shown in figure 2. These will form the viewing ports.

Figure 1

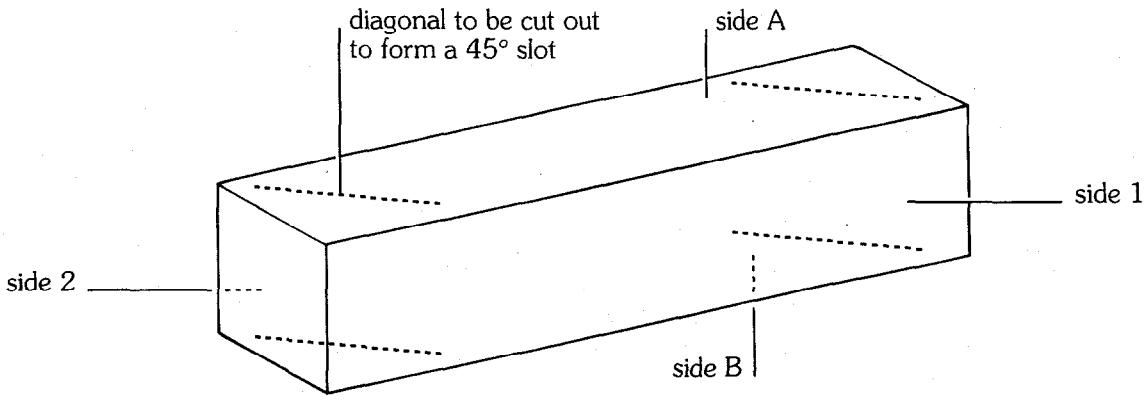
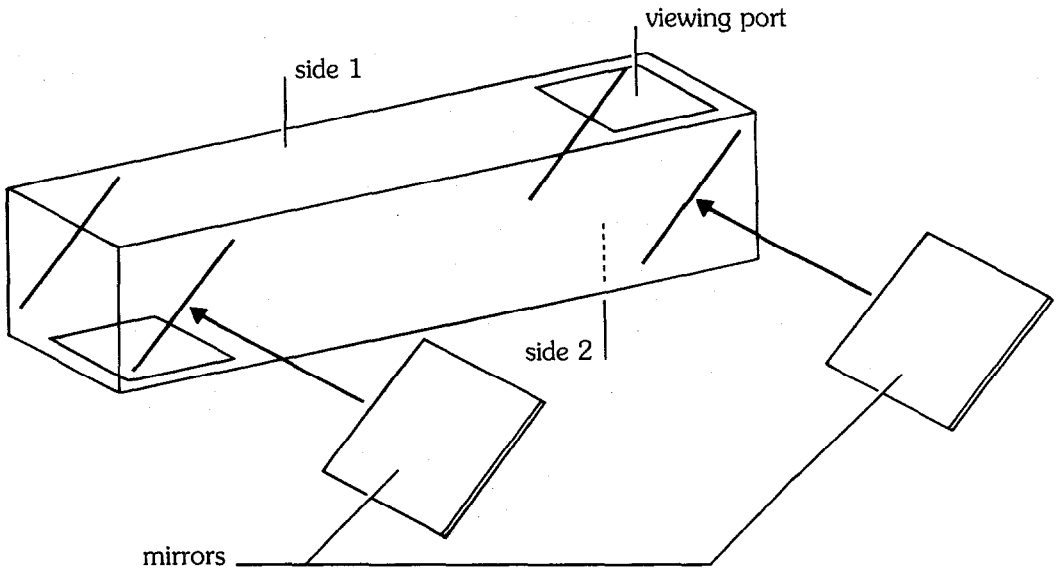


Figure 2



5. Carefully mount a mirror in each of the diagonal slots, making sure that the mirrored surfaces are facing one another. Secure the mirrors by taping them into place along either side of the mounting slots. Use dark tape to seal any gaps around the mirrors to prevent stray light from entering.

6. Use your periscope to look around a corner or to look over something to observe an object. Do not aim the periscope at the sun, and do not attempt to walk about when viewing through the periscope—your vision will be restricted.

ANALYSIS:

1. Is the image you see through the periscope reversed or is it the correct way around?

2. Do some research. Draw a side view of the periscope in cross-section and show the path that the light rays take. On your drawing indicate the angles between the light rays and the mirrors.

3. Imagine constructing a periscope in which the viewing slots are both on the same side, and the mirrors are set at right angles to one another. You would be able to look behind you. Draw a diagram to show the path taken by the light rays in this type of periscope. How would the image appear to you?

4. Do some research. Periscopes are used in armored tanks and in submarines. What are the key differences in the design of these two types of periscope?

OUR FINDINGS:

Click on above link to see what we found.

SPECIAL SAFETY NOTE TO INVESTIGATORS

Each invention includes any special safety precautions that are relevant to that particular project. These do not include all of the basic safety precautions that are necessary whenever you are working on a scientific investigation. For this reason, it is absolutely necessary that you read, copy, and remain mindful of the General Safety Precautions that follow this note.

Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly when you are constructing or demonstrating a model invention. Things can spill, break, even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following basic safety guidelines the *entire* time you are carrying out the project, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual projects. We made this choice for one reason: We want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each project you are preparing to perform, and that you will *remember* them. Except in rare instances, these precautions will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not say BE CAREFUL WITH HOT LIQUIDS or DON'T CUT YOURSELF WITH THE KNIFE does not mean that you should be careless when simmering water or stripping an electrical wire. It does mean that when you see a special note to be careful, it is extremely important that you pay attention to it.

If you ever have a question about whether a procedure or material is dangerous, wait to perform it until you find out for sure that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks can be avoided by practicing safety procedures and being alert while carrying out these projects. Be sure to check the individual projects in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone.

PREPARING:
—Clear all surfaces before beginning projects
—Read the instructions before you start
—Know the hazards of the procedures and anticipate dangers

PROTECTING YOURSELF:
—Follow the directions step-by-step; do only one project at a time
—Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eye wash, and first-aid kit
—Make sure there is adequate ventilation
—Do not horseplay
—Wear an apron and goggles
—Do not wear contact lenses, open shoes, loose clothing, or loose hair
—Keep floor and work space neat, clean, and dry
—Clean up spills immediately
—Never eat, drink, or smoke in laboratory or work space
—Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult

USING EQUIPMENT WITH CARE:
—Set up apparatus far from the edge of the desk or bench
—Use knives and other sharp or pointed instruments with caution
—Pull plugs, not cords, when removing electrical plugs
—Clean glassware before and after use
—Check glassware for scratches, cracks, and sharp edges
—Clean up broken glassware immediately
—Do not touch metal conductors
—Use only low voltage and current materials such as lantern batteries
—Be careful when using stepstools, chairs, and ladders
—Never look directly at the sun with your observation devices

USING CHEMICALS:
—Never taste or inhale chemicals
—Label all bottles and apparatus containing chemicals
—Read labels carefully
—Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves)
—Do not touch chemical solutions
—Wash hands before and after using solutions
—Wipe up spills thoroughly

HEATING SUBSTANCES:
—Use goggles, apron, and gloves when boiling water
—Keep your face away from test tubes and beakers
—Never leave apparatus unattended
—Use safety tongs and heat-resistant mittens
—Turn off hot plates, bunsen burners, and gas when you are done
—Keep flammable substances away from heat
—Have fire extinguisher on hand

FINISHING UP:
—Thoroughly clean your work area and glassware
—Be careful not to return chemicals or contaminated reagents to the wrong containers
—Don't dispose of materials in the sink unless instructed to do so
—Wash your hands
—Clean up all residue and put in proper containers for disposal
—Dispose of all chemicals according to all local, state, and federal laws

BE SAFETY CONSCIOUS AT ALL TIMES