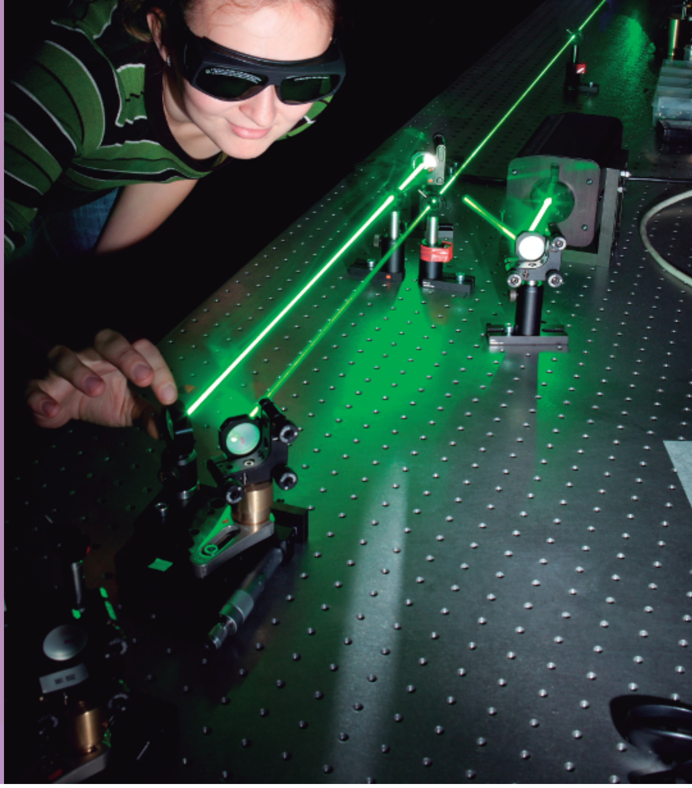
UNIT 2

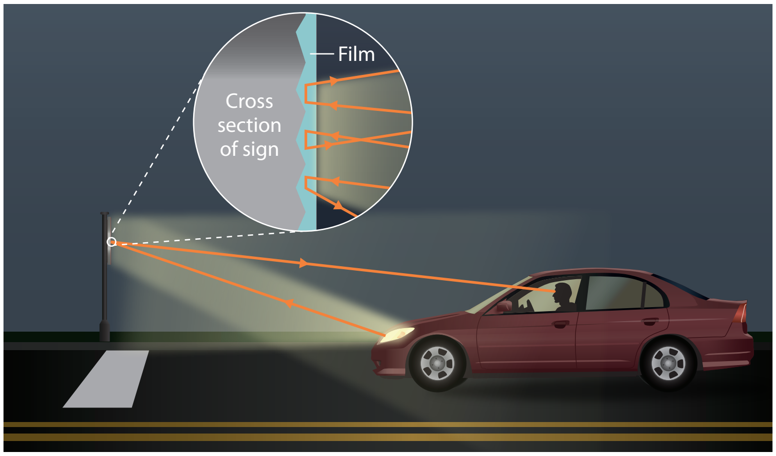
Lines, Angles, and Triangles

Mathematics and Optical Physics

The field of optical physics involves the study of the properties of light and how light rays interact with matter. Optical physicists have developed products that reflect light rays to enhance the luminosity of objects, such as road signs and light sources. They design surfaces covered with microscopic structures—tiny bumps, ridges, indentations, and furrows—that bend and reflect light. Optical physicists use their knowledge of geometry to determine the angle that light is reflected off a microstructure or the angle it is bent when it passes through the structure.



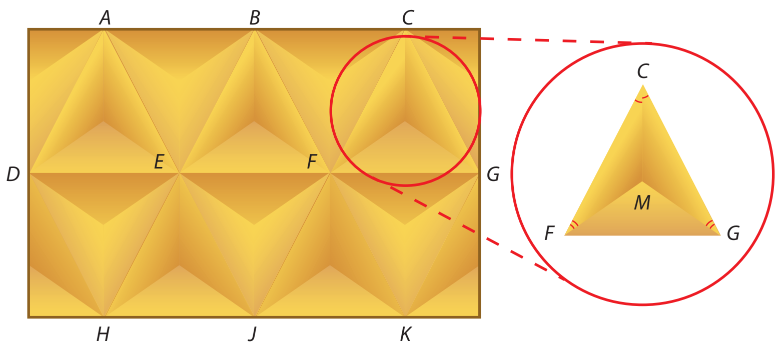
A road sign appears brightly lit because of a special film designed by optical physicists that is applied to the front surface of the sign. The back of the film contains about 7000 tiny pyramids per square inch. The base of each pyramid is an isosceles triangle. All of these triangles are congruent. The light passes through the film and reflects inside the pyramids on the back. The pyramids are designed to reflect the light from the headlights back to the driver, no matter where the car is. This allows drivers to see the signs from any position on the road.



As optical physicists work to improve the film, they need to understand the geometric relationships between the surfaces of these microstructures and the location of the light source illuminating them. To achieve the desired effects, the precise shape, angle, and position of these structures must be designed carefully.

Exercises

Optical physicists design surfaces made up of millions of tiny microstructures. The reflective film used on road signs, described on the preceding page, is one example. The back of the film has thousands of tiny pyramids with congruent bases on it. The figures below show a magnified view of a portion of the back of the film and a single pyramid.



1. **a.** It appears that $\triangle AEB \cong$ ________.

   b. How many triangles with labeled vertices appear to be congruent to $\triangle AEB$?

   c. Can you identify another, larger pair of triangles with labeled vertices that appear to be congruent?

2. **a.** Prove that $\triangle FCM \cong \triangle GCM$.

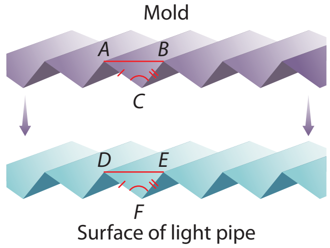
   b. Explain how you can conclude that $\triangle FCG$ is isosceles.

   c. Name another isosceles triangle in the pyramid on the right. Explain how you know that it is isosceles.

Optical physicists have also designed the microstructures found in light pipes. Light pipes are smooth on the inside and grooved on the outside. This design allows light entering at one end to travel down the pipe, while allowing some of the light to leak out along the way. Light pipes are used in many diverse applications, such as in electronic devices and skylights. The surface of one such light pipe is shown below.

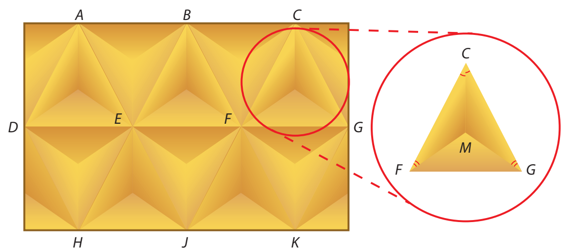
3. **a.** What is the meaning of the single and double line segments in the figure?

   b. A mold is used to make tiny parallel ridges on the outside of the pipe. The ridges and mold fit together as shown. What postulate can you use to explain why $\triangle ABC \cong \triangle DEF$?



Exercises

Optical physicists design surfaces made up of millions of tiny microstructures. The reflective film used on road signs, described on the preceding page, is one example. The back of the film has thousands of tiny pyramids with congruent bases on it. The figures below show a magnified view of a portion of the back of the film and a single pyramid.



1. **a.** It appears that $\triangle AEB \cong$ ________. **Sample answer: $\triangle BFC$**

   b. How many triangles with labeled vertices appear to be congruent to $\triangle AEB$? **nine**

   c. Can you identify another, larger pair of triangles with labeled vertices that appear to be congruent? **Sample answer: $\triangle AJC \cong \triangle HBK$**

2. **a.** Prove that $\triangle FCM \cong \triangle GCM$. **See margin.**

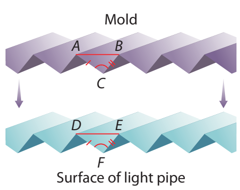
   b. Explain how you can conclude that $\triangle FCG$ is isosceles. **See margin.**

   c. Name another isosceles triangle in the pyramid on the right. Explain how you know that it is isosceles. **See margin.**

Optical physicists have also designed the microstructures found in light pipes. Light pipes are smooth on the inside and grooved on the outside. This design allows light entering at one end to travel down the pipe, while allowing some of the light to leak out along the way. Light pipes are used in many diverse applications, such as in electronic devices and skylights. The surface of one such light pipe is shown below.

3. **a.** What is the meaning of the single and double line segments in the figure? **See margin.**

   b. A mold is used to make tiny parallel ridges on the outside of the pipe. The ridges and mold fit together as shown. What postulate can you use to explain why $\triangle ABC \cong \triangle DEF$? **SAS Postulate**



Answers

2a. 1. $\angle FCM \cong \angle GCM$ Given
2. $\angle CFM \cong \angle GCM$ Given
3. $\overline{CM} \cong \overline{CM}$ Reflexive Property of Equality
4. $\triangle FCM \cong \triangle GCM$ AAS Postulate

2b. $\triangle FCM \cong \triangle GCM$, so $\overline{FC} \cong \overline{GC}$. Because $\triangle FCG$ has two congruent sides, $\triangle FCG$ is isosceles.

2c. $\triangle FMG$ is isosceles. Sample answer: Because $\triangle FCM \cong \triangle GCM$, $\overline{FM} \cong \overline{GM}$. Therefore, because $\triangle FMG$ has two congruent sides, it is isosceles.

3a. Sample answer: Sides with the same markings are congruent.