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Department of Education
National Capital Region
SCHOOLS DIVISION OFFICE
MARIKINA CITY

Science

Quarter 2 – Module 5

Applications of Mirrors and Lenses

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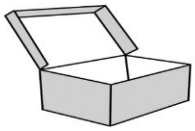


What I Need to Know

The purpose of this module is to help you understand the applications of mirrors and lenses.

After going through this module, you are expected **to identify ways in which the properties of mirrors and lenses determine their use in optical instruments (e.g., cameras and binoculars). S10FE-IIh-52**

Specifically, you are expected to:

- analyze the image formed by a set of mirrors or lenses using ray diagramming technique;
- explain the use of mirrors and lenses in telescopes;
- explain the use of mirrors and lenses in binoculars; and
- explain the use of mirrors and lenses in microscopes.

What I Know

Read and understand each item carefully and encircle the letter of the correct answer.

1. What kind of eyepiece is used in a reflecting telescope?
   A. Convex lens
   B. Convex mirror
   C. Concave lens
   D. Concave mirror

2. What is the orientation of the image produced by a Galilean telescope with respect to the object?
   A. Inverted
   B. Real
   C. Upright
   D. Virtual

3. Why do astronomers prefer to use a reflecting telescope in viewing astronomical objects?
   A. It collects less light than lenses.
   B. It can preserve the colors of the object.
   C. It creates a clearer image of the object.
   D. It produces an upright image of the object.

4. Which optical instrument offers the widest field of view?
   A. Binoculars
   B. Compound microscope
   C. Magnifying glass
   D. Telescope

5.What is the purpose of prisms in a binocular?

A. It magnifies the object.
B. It adds weight to the device.
C. It allows the device to be shorter.
D. It allows greater resolution of the image.

6. Which shows the correct sequence of image formation in reflecting telescopes?

I. The light rays refract on the eyepiece producing an enlarged image.
II. Light from the distant object enters the telescope.
III. Light converges after hitting the parabolic mirror.
IV. A plane mirror catches and redirects the light.

A. II, III, IV, I
B. II, IV, III, I
C. IV, II, I, III
D. I, II, III, IV

7.Which statement is **TRUE** about a compound microscope?

A. It only uses a single lens.
B. It can produce smaller images.
C. It is used to view very small objects.
D. It creates a clear image of a distant object.

8.Which instrument produces a virtual, larger, and upright image?

A. Cassegrain telescope
B. Keplerian telescope
C. Compound microscope
D. Simple microscope

9.What happens to the image formed in a compound microscope when the eyepiece lens is adjusted far from the focal point of the objective lens?

A. Image will become blurred.
B. No image will be formed.
C. The image will be magnified.
D. The image will diminish.

10. An enlarged image of a cell was flashed on a screen. Which optical set was used to produce the image?

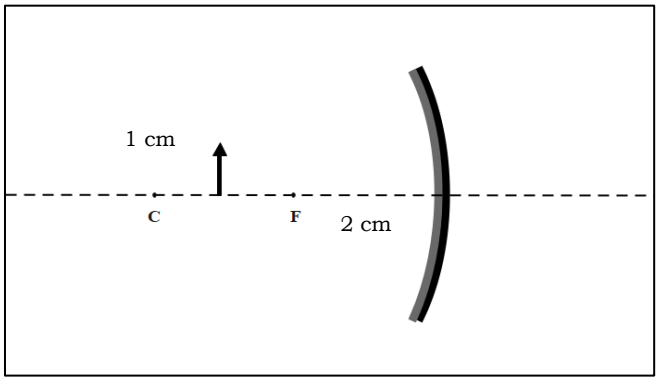
A. Parabolic mirror and convex lens
B. Parabolic mirror and plane mirror
C. Single convex lens
D. Two convex lenses

Lesson	Applications of Mirrors and Lenses

What's In

Based on what you have learned in the previous module, apply the ray diagramming technique to locate the image formed on the following mirror and lens. Describe the image formed using **SOLT** (Size, Orientation, Location, and Type) of the image formed.

1.



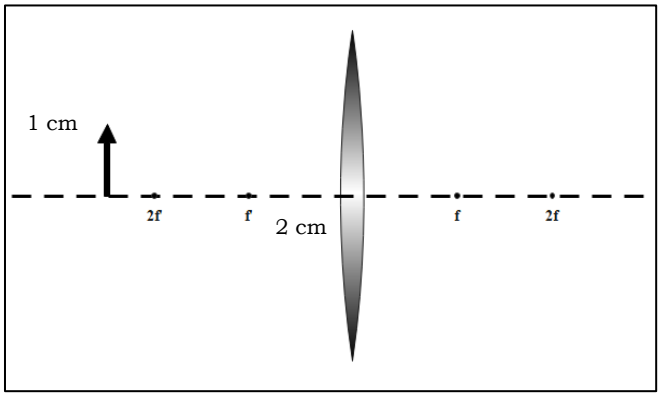
Size: _____

Orientation: _____

Location: _____

Type: _____

2.



Size: _____

Orientation: _____

Location: _____

Type: _____

What's New

Activity 1: Mirror and Lens System

Objectives:

1. Analyze the image formed by a set of mirrors and lenses using ray diagramming technique.
2. Describe the *Size, Orientation, Location, and Type* (S.O.L.T.) of the image produced by the given set of mirrors and lenses.

You Will Need:

Figure 1. **Ray diagram in mirror and lens set (Reflecting telescope)**

Procedure:

1. Analyze the ray diagram in the mirror and lens set below and answer the questions on a separate sheet of paper.

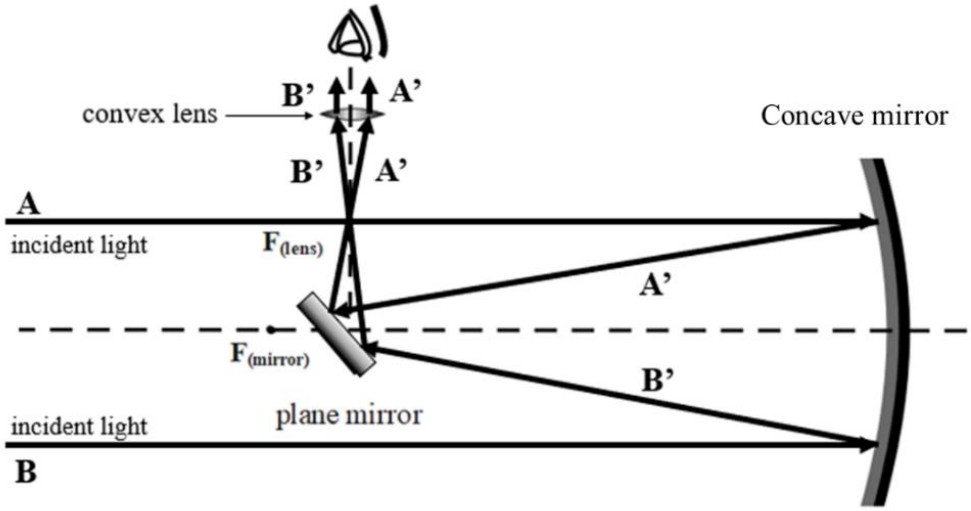


Figure 1. **Ray diagram in mirror and lens set (Reflecting telescope)**

Guide Questions:

1. Figure 1 shows an incident light ray A and B hits the parabolic mirror.
   a. What does the parallel incident light rays tell us about the object?

   b. What will happen to the light after it reaches the parabolic mirror?

   c. How will you describe the size, orientation, and type of the image after reflecting on the concave mirror with respect to the object?

2. A plane mirror was placed at the center.
   a. What did the plane mirror do to the light rays?

3. A convex lens was placed in front of the observer's eye.
    a. How will you describe the size, orientation, and type of the image perceived by the observer with respect to the object?

    b. What do you think will be the effect on the image formation if you adjust the distance of the convex lens from the plane mirror?

What Is It

The activity demonstrates the effect of reflection and refraction to image formation. You noticed that the Size, Orientation, Location, and Type (S.O.L.T) of the image will depend on the medium used. Moreover, combining mirrors and lenses greatly affects the final image produced. For instance, parallel incident light depicts that the object is of great distance and appears to be very small, however, after hitting the parabolic mirror, the image will be reduced in size and will change its orientation.

Figure 2 shows how the mirrors and lenses allow the formation of the image following the laws of reflection and refraction. The parabolic shape of the mirror allows the light to gather and converge in its focal point which creates a smaller, inverted, and real image. The plane mirror which reflects the image it receives, redirects the light to the objective lens. At this point, it is important to adjust the lens so that the image formed by the concave mirror will be located between the focal point and the lens. Therefore, the Newtonian telescope produces an image that is larger, inverted, and virtual with respect to the object.

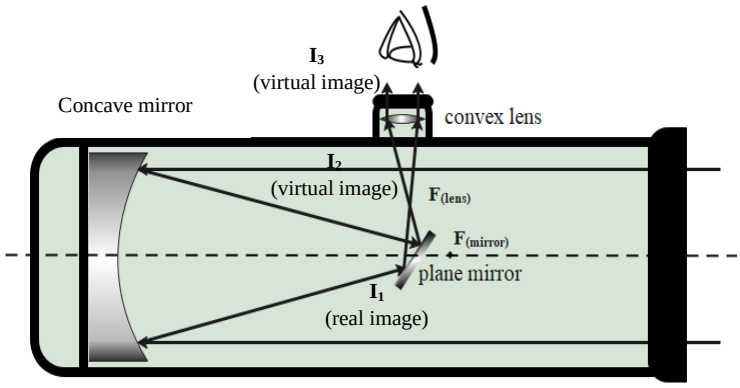


Figure 2. **Image formation in a Newtonian Reflecting telescope**

Telescopes

Discoveries of distant objects in the sky have been made possible with the invention of telescopes. A **telescope** is an optical device which presents a magnified image of distant objects using parabolic mirrors or lenses. Initially, people used **refracting telescopes** such as the **Keplerian telescope** and **Galilean telescope** which use lenses to observe distant objects. Figure 3 shows the formation of the image as the light from the object passes through a set of convex lenses in a Keplerian telescope.

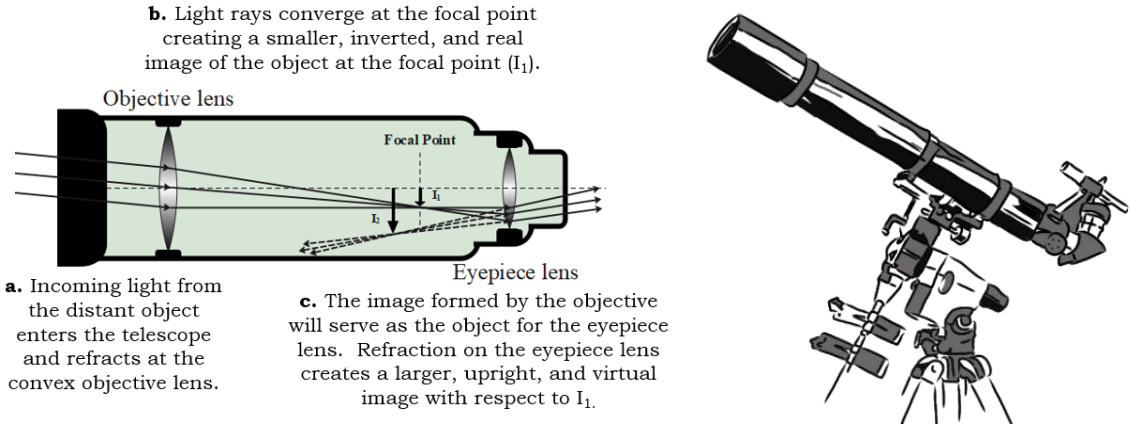


Figure 3. **Image formation in a Keplerian Telescope**

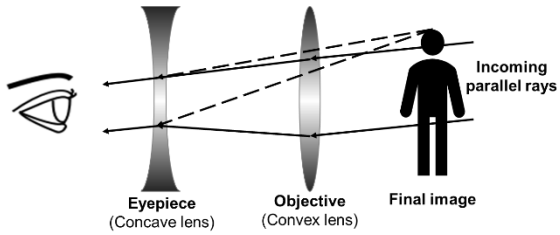


Figure 4. **Image formation in a Galilean Telescope**

Another type of refracting telescope that uses a concave lens for the eyepiece is known as the **Galilean telescope**. This type of telescope creates an image that is larger, upright, and virtual (see Figure 4).

The use of refracting telescopes allows the astronomers to explore distant objects. However, the use of lens becomes difficult with the attempt to gather more light by using large objective lens for telescopes. Larger lenses tend to distort its shape due to its weight. This is known as **lens sag** (see Figure 5a). Light passing through a lens also experiences dispersion known as **chromatic aberration** which is why images produced are blurred (see Figure 5b).

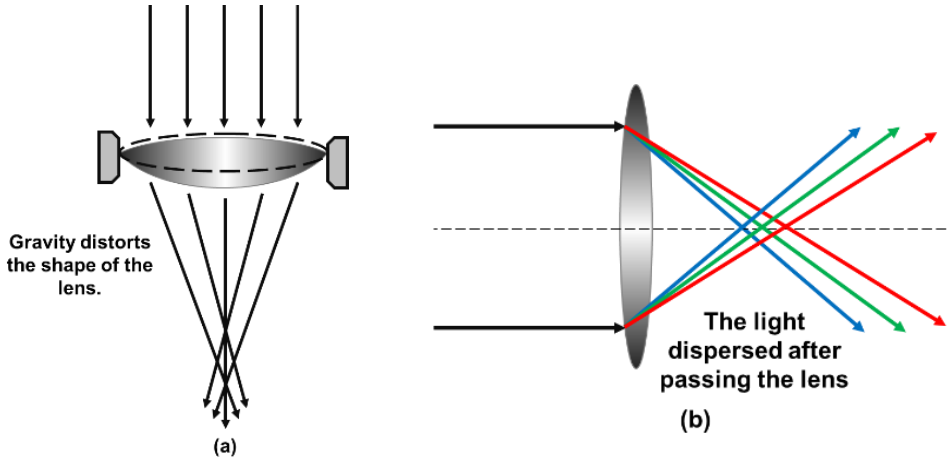


Figure 5. **Drawbacks of the use of lenses in telescopes**
(a)Lens sag, (b) Chromatic aberration in lenses

Reflecting telescopes, on the other hand, uses parabolic mirrors which can be supported from the back to avoid sag and produces images without chromatic aberration (see figure 6). This is why reflecting telescopes are preferred by astronomers in observing the heavenly bodies.

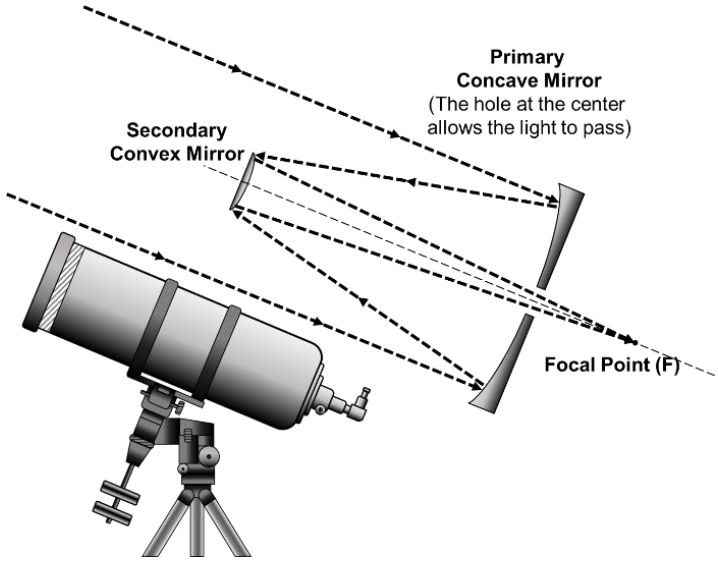


Figure 6. **Image formation in a Cassegrain Reflecting telescope**

Figure 6 shows the path of the light ray in a **Cassegrain reflecting telescope**. This type of reflecting telescope uses a convex mirror situated in the middle of the telescope to redirect the incoming light from the concave mirror. This process produces a larger, inverted, and real image of the distant object.

Binocular

Binoculars offer similar functions as the telescope—they are used to view far objects. However, this instrument is handheld and has two telescopes attached to a single frame. Each part has convex lenses in its objective and eyepiece, and a pair of *Porro prisms*. **Prisms** are used to make the instrument shorter. It folds the path of the light rays and inverts it to produce an image with the same orientation as the object.

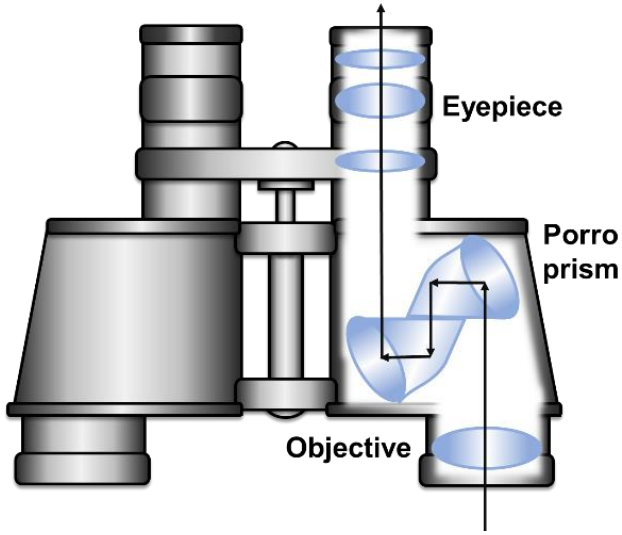


Figure 7. **Cross section of a binocular**

Binoculars are often used to view terrestrial objects such as safari viewing, spying, and even star gazing. Although it can be used to view astronomical objects because of its wider field of view, high magnification of the lenses will be required.

Microscope

Microscopes are optical instruments that aid the eye in observing small objects. It uses a set of lenses to create a larger image for observation. A **simple microscope** known as the **magnifying glass** is a single lens optical device which can enlarge objects from 2 to 6 times its original size (see figure 8). The magnification of an object can be improved by adding a series of lenses into the system to create a larger view. This is how **compound microscopes** work. Figure 9 shows how series of lenses refracts light to create a larger, inverted, and virtual image with respect to the first image ($\mathbf{I_1}$).

Figure 8. **Text seen through a magnifying glass**
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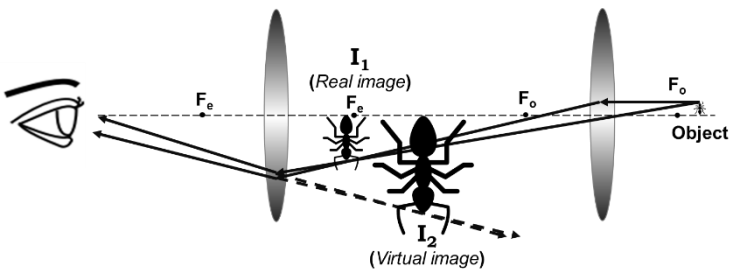

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Figure 9. **Image formation in a Compound Microscope**

What's More

Match column A with the appropriate term in column B. Write your answers on the space provided before each number.

A	B
_____1. An instrument that uses a set of lenses to magnify small objects.	A. Chromatic aberration
_____2. An optical device which uses single lens to enlarge small objects.	B. Compound microscope
_____3. The result of the dispersion of light which causes blurring of image formed.	C. Lens sag
_____4. A device which uses mirrors to observe far objects.	D. Magnifying glass
_____5. A telescope which uses system of lenses to enlarge distant objects.	E. Reflecting telescope
	F. Refracting telescope

What I Have Learned

Complete the table below.

Optical Device	Optical Set Used		Description of final image formed		
	Type of lens *(Convex/ Concave)*	**Type of mirror** *(Convex/ Concave/ Plane)*	**Size** *(Larger or smaller)*	**Orientation with respect to the object** *(Upright or Inverted)*	**Type** *(Real/ Virtual)*
Telescope					
A. Keplerian	**1.**		**2.**	Inverted	Real
B. Galilean	Convex and **3.**		Larger	**4.**	**5.**
C. Newtonian	Convex	Concave and **6.**	Larger	Inverted	**7.**
D. Cassegrain	**8.**	Concave and **9.**	Larger	**10.**	Virtual
Binocular	Convex		**11.**	Upright	Virtual
Magnifying glass	**12.**		Larger	**13.**	**14.**
Compound microscope	Convex		Larger	**15.**	Real

What I Can Do

Using a ray diagram, show how the image will reach the eyepiece as the light rays passes through the lenses and mirrors inside the camera.

Continue to draw the path of light rays on Figure 10 after it hits the plane mirror until it reaches the eyepiece.

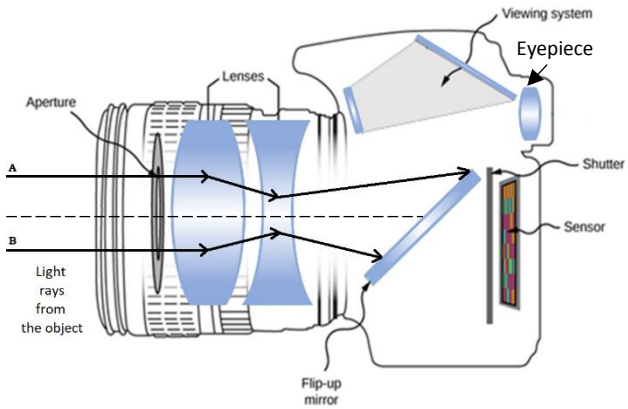

Figure 10. **Mirror and Lens System of a Camera**
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Assessment

Analyze each statement carefully. Write TRUE if the statement is correct and FALSE if the statement is incorrect.

_____1.Reflecting telescope gathers more light than refracting telescopes.
_____2.Binoculars are great for stargazing because of its narrow field of view.
_____3.The microscope produces a larger, virtual image of the object.
_____4.In telescopes, mirrors are much more convenient to use than lenses.
_____5.A magnifying glass can make a distant object appear larger.

Additional Activities

Performance Task: **Improvised Optical Device**

Create your own optical device using indigenous and recycled materials. You may choose one of the optical devices best suited to the available resources in your home.

1. VR Goggles
2. Projector
3. Kaleidoscope

Rubrics for scoring (created at http://rubistar.4teachers.org)

CATEGORY	4	3	2	1	Score
Scientific Knowledge	Explanations by all group members indicate a clear and accurate understanding of scientific principles underlying the construction and modifications.	Explanations by all group members indicate a relatively accurate understanding of scientific principles underlying the construction and modifications.	Explanations by most group members indicate relatively accurate understanding of scientific principles underlying the construction and modifications.	Explanations by several members of the group do not illustrate much understanding of scientific principles underlying the construction and modifications.	
Information Gathering	Accurate information taken from several sources in a systematic manner.	Accurate information taken from a couple of sources in a systematic manner.	Accurate information taken from a couple of sources but not systematically organized.	Information taken from only one source and/or information not accurate.	
Construction -Materials	Appropriate materials were selected and creatively modified in ways that made them even better.	Appropriate materials were selected and there was an attempt at creative modification to make them even better.	Appropriate materials were selected.	Inappropriate materials were selected and contributed to a product that performed poorly.	
Function	Structure functions extraordinarily well, holding up under atypical stresses.	Structure functions well, holding up under typical stresses.	Structure functions pretty well but deteriorates under typical stresses.	Fatal flaws in function with complete failure under typical stresses.	
				Total score:	

Posttest

Read and understand each item carefully and encircle the letter of the correct answer.

1. Which is the correct orientation of the image produced by a Galilean telescope with respect to the object?
   A. Virtual
   B. Upright
   C. Real
   D. Inverted

2. Why do astronomers prefer to use reflecting telescope in viewing astronomical objects?
   A. It produces an upright image of the object.
   B. It creates a clearer image of the object.
   C. It can preserve the colors of the object.
   D. It collects less light than lenses.

3. A group of tourists wishes to see the “milky way”. Which optical instrument will give them a wider field of view?
   A. Binoculars
   B. Compound microscope
   C. Magnifying glass
   D. Telescope

4. A compound microscope uses a system of lenses. Which property of light is observed in this device?
   A. Dispersion
   B. Diffraction
   C. Reflection
   D. Refraction

5. Which instrument produces a virtual, larger, and upright image?
   A. Astronomical telescope
   B. Camera
   C. Compound microscope
   D. Simple microscope

6. How would you describe the image produced by a microscope?
   A. Smaller and upright
   B. Smaller and inverted
   C. Larger and inverted
   D. Larger and upright

7. Which shows the correct sequence of image formation in reflecting telescopes?
   I. The light rays refract on the eyepiece producing an enlarged image.
   II. Light from the distant object enters the telescope.
   III. Light converges after hitting the parabolic mirror.
   IV. A plane mirror catches and redirects the light.
   A. I, II, III, IV
   B. II, IV, III, I
   C. IV, II, I, III
   D. II, III, IV, I

8. What happens to the image formed in a compound microscope when the eyepiece lens is adjusted far from the focal point of the objective lens?
   A. No image will be formed.
   B. The image will diminish.
   C. Image will become blurred.
   D. The image will be magnified.

9. An enlarged image of a cell was flashed on a screen. Which optical set was able to produce the image?
   A. Concave mirror and convex lens
   B. Concave mirror and plane mirror
   C. Single convex lens
   D. Two convex lenses

10. Reflecting telescopes and microscopes produce an enlarged image of the object. Which is TRUE about these optical instruments?
   A. Microscopes are for tiny objects; telescopes are for distant objects.
   B. Microscopes are for distant objects; telescopes are for tiny objects.
   C. Both optical instruments produce an inverted image.
   D. Both optical instruments produce real images.

Answer Key

What's In	What's More	What I Have Learned	Assessment
Lesson 1 1. S – Larger O – Inverted L – Beyond C T – Real 2. S – Smaller O – Inverted L – Bet. F and 2F T – Real	Lesson 1 1. B 2. D 3. A 4. E 5. F	Lesson 1 1. Convex lens 2. Larger 3. Concave lens 4. Upright 5. Virtual 6. Plane 7. Virtual 8. Convex lens 9. Convex 10. Inverted 11. Larger 12. Convex lens 13. Upright 14. Virtual 15. Inverted	1. TRUE 2. FALSE 3. FALSE 4. TRUE 5. FALSE

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