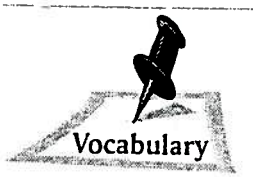
Lesson 4

Concave and Convex Mirrors and Lenses



- **optical device**
- **lens**
- **convex lens**
- **converges**
- **focal point**
- **concave lens**
- **plano**
- **focal length**
- **convex mirror**
- **concave mirror**

Learning Outcomes

After completing this lesson you will be able to

- determine how light interacts with concave and convex mirrors and lenses
- provide examples of their use in various optical instruments and systems
- demonstrate the formation of images using a double convex lens
- predict the effects of changes in lens position on the size and location of the image

What Is a Lens?

Have you ever snapped a photo or looked through a microscope? If your answer is yes, then you have used an **optical device.**

There are many kinds of optical devices. Cameras and microscopes are two examples. Others are projectors, binoculars, telescopes, and even eyeglasses.

Every optical device is different. But they all have one thing in common. Each one has at least one **lens**.

What is a lens? A lens is a transparent substance that bends or refracts light in a definite way.

Most lenses are made of glass. Many lenses are made of plastic.

Most lenses have one or two curved surfaces.

There are two main types of lenses: convex and concave.

- A **convex lens** is thicker at the centre than at the edge. It magnifies or makes things look bigger.

A convex lens brings together, or **converges**, light rays. The point where the light rays meet is called the **focal point.**

* From *Physics Workshop 3: Understanding Light and Sound* by Seymour Rosen. © by Globe Fearon, an imprint of Pearson Learning Group, a division of Pearson Education, Inc. Used by permission.

Light that passes through a convex lens can be focused on a screen or other surface. This forms an image of the object that gave the light. Convex lenses are used in projectors and cameras.

- A **concave lens** spreads out light rays. They cannot form an image on a screen.

Thinner in the centre ("caves" in)

Concave lenses are often used together with convex lenses. They help the convex lenses give sharper images.

Most eyeglass lenses have combinations of concave and convex curves.

Questions: Understanding Lenses

Six lenses are shown in Figure A. Study them. Then answer the questions by writing the correct letters. Many questions will have more than one answer.

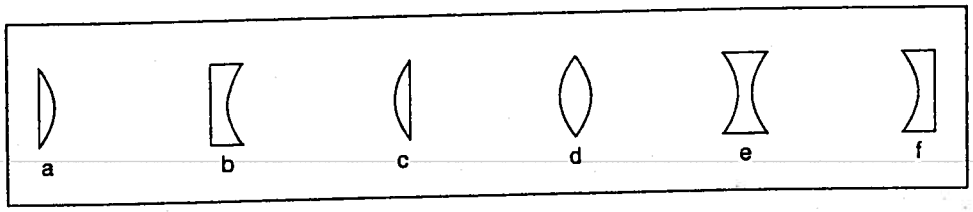


Figure A

What You Need To Know:
Plano means "plane" or "flat."

Which lens or lenses . . .

1. are thicker at the centre than at the edge? a, c, d
2. are thinner at the centre than at the edge? b, e, f
3. are *concave*? b, e, f
4. are *convex*? a, c, d
5. are plano *convex*? a, c
6. are plano *concave*? b, f
7. is *double concave*? e
8. is *double convex*? d

Which lenses . . .

9. magnify? a, c, d

10. ~~minify~~ reduce? b, e, f

11. *refract* light? all

12. *converge* light? a, c, d

13. *spread out* light? b, e, f

14. *can* form an image on a screen? a, c, d.

15. *cannot* form an image on a screen? b, e, f

16. are most important for projectors and cameras? a, c, d

Now look at Figure B.

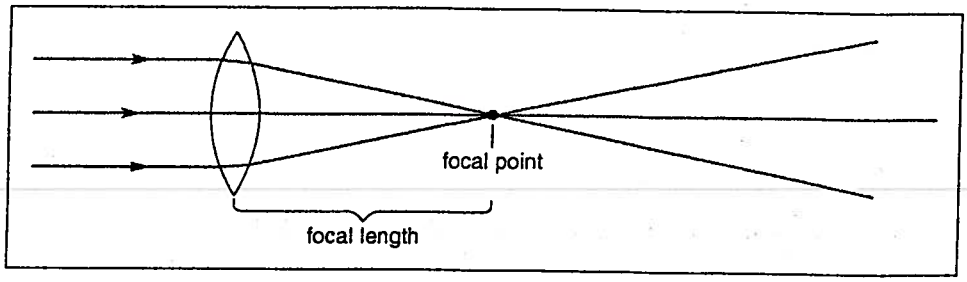


Figure B

17. a. Figure B shows a convex (concave, convex) lens.

b. It converges (converges, spreads) light rays.

18. What do we call the point where light rays converge?

focal point

19. What do we call the distance between a lens and its focal point?

focal length

Learning Activity: About Focal Length

Different lenses have different **focal lengths**.

Focal length depends upon the strength of a lens.

- The *stronger* the lens, the shorter the focal length.
- The *weaker* the lens, the longer the focal length.

A strong lens has a deeper curve than a weak lens.

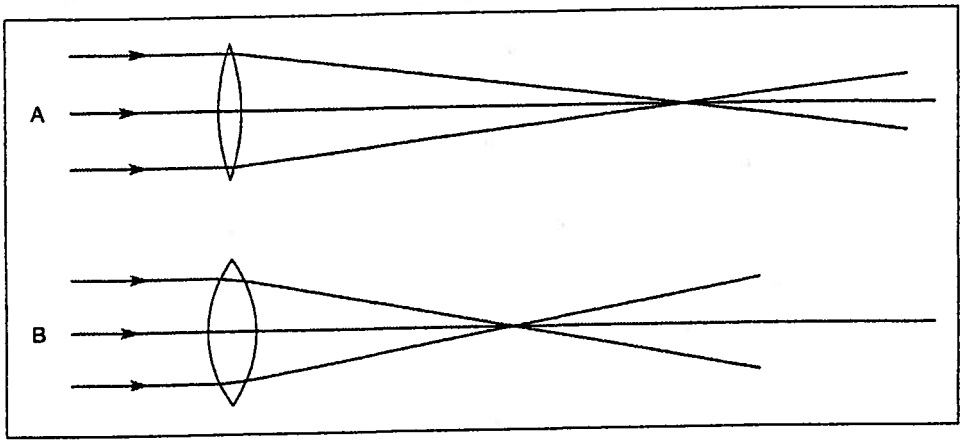


Figure C

Two converging lenses are shown in Figure C. Study the figure. Then answer the questions by writing the correct letters.

Which lens

1. is *more* curved? b
2. is *less* curved? a
3. is *stronger*? b
4. is *weaker*? a
5. refracts light *less*? a
6. refracts light *more*? b
7. has the *shorter* focal length? b
8. has the *longer* focal length? a
9. magnifies *more*? b
10. magnifies *less*? a

Now Look at Figure D.

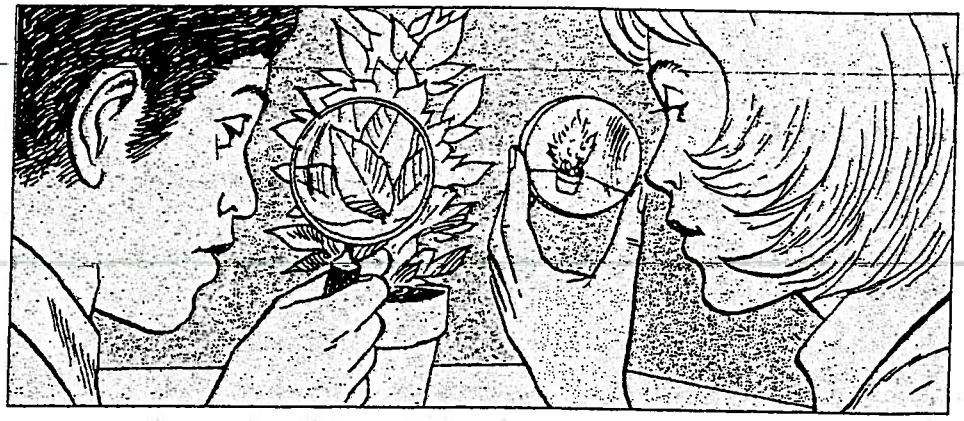


Figure D

11. What kind of lens is the boy holding?

convex

12. What kind of lens is the girl holding?

Concave

Convex and Concave Mirrors

A **convex mirror** produces a small image standing right side up. It reflects back a larger area than a concave mirror does. Convex mirrors are used for security purposes in stores.

A **concave mirror** can reflect in two different ways:

- if the object is close, the mirror will make it appear larger and right side up.
- if the object is farther away, the mirror will make it appear smaller and upside down. Concave mirrors are used for shaving.

Questions: Convex and Concave Mirrors

1. Where are convex mirrors used? Give two examples.

security in stores, - mirrors to see around corner
vehicle rear-view mirrors,

2. Where are concave mirrors used? Give two examples.

- cosmetic, shaving, dentist mirrors

Mail-in Assignment #4

Investigating Lenses

~~There are two parts to this assignment.~~ Part One is a directed investigation where you will follow the steps provided to answer a specific testable question. [redacted] You will use the double concave lens and double convex lens ~~you~~ [redacted]

Note: As you work through both parts of this assignment, pay close attention to the marks assigned. For example, a 4-mark question will require a more extensive or detailed response than a 1-mark question.

Part 1: Viewing Near and Distant Objects (15 marks total)

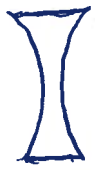
Read through the assignment before you begin.

In this part of the assignment you will answer the following testable question: **What affect does changing the distance between the lens and the object viewed have on the orientation and size of the image produced using a convex lens and a concave lens?**

Mail-In Assignment: Pages 38-42 will be handed in to your tutor/marker.

Note: "Orientation" refers to whether the image is upright or upside down. "Size" refers to whether the image is larger or smaller than the original object.

1. a. Draw a diagram of the two types of lenses you have in the spaces below. The diagrams must clearly show the differences between the lenses (you can draw a side view if you wish). (2 marks)



Double ~~Convex~~ Lens
Concave

Double Convex Lens

b. In your own words, describe how the two lenses compare. (1 mark)

Double concave - thinner in the middle
Double convex - thicker in the middle

2. Identify the independent variable. (1 mark)

[TYPE OF LENS]
* distance from lens to object

3. Identify the dependent variable. (1 mark)

size + orientation of the image

4. Record your predictions. What do you predict will happen with both lenses? (2 marks)

Convex lens:

The image will appear larger and right side up when the object is up close; smaller and upside down when far away

Concave lens:

The image will be smaller and right side up when the object is close.
The image will be smaller and right side up when the object is farther away.

5. Complete the experiment following the steps below.
   a. Using the convex lens, hold it at a comfortable distance from your eye (e.g., 14-15 cm.).
   b. Look at an object in the room that is nearby (about 1 metre away) and record your observations in the table below.
   c. Look at an object that is across the room (about 3-4 metres away) and record your observations in the table below.
   d. Repeat the steps a-c with the concave lens and record your observations.

6. Record your observations. (4 marks)
   Record your observations in the table below. Use the following terms to help describe what you saw:
   larger / smaller than the original image, upright / upside down
   Include any additional observations you can make. Use an additional page if you need more space.

	The object 1 metre away appears:	The object 3-4 metres away appears:
Convex Lens	- right side up - bigger than the original	- upside down - smaller than the original
Concave Lens	- right side up - smaller	- right side up - smaller.

7. Write a concluding statement for each type of lens. (4 marks)

Convex lens:

Image appears larger and right side up if object is close; smaller and upside down if far away.

Concave lens:

Image appears smaller and right side up if object is close
Image appears smaller and right side up if object farther away.