Attachment #8

AIM 20 | 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* [kon VEKS] and *concave* [kon KAVE].

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

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

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 is thinner at the center than at the edge. It *minifies* or makes things look *smaller.*

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

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.

UNDERSTANDING LENSES

Six lenses are shown in Figure A. Study them. Then answer the questions by writing the correct letters.

Figure A

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

Which lens or lenses . . .

1. are thicker at the center than at the edge? _____
2. are thinner at the center than at the edge? _____
3. are *concave*? _____
4. are *convex*? _____
5. are *plano convex*? _____
6. are *plano concave*? _____
7. is *double concave*? _____
8. is *double convex*? _____

Which lenses . . .

9. magnify? _____
10. minify? _____
11. *refract* light? _____
12. *converge* light? _____
13. spread out light? _____
14. *can* form an image on a screen? _____
15. *cannot* form an image on a screen? _____
16. are most important for projectors and cameras? _____

Now look at Figure B.

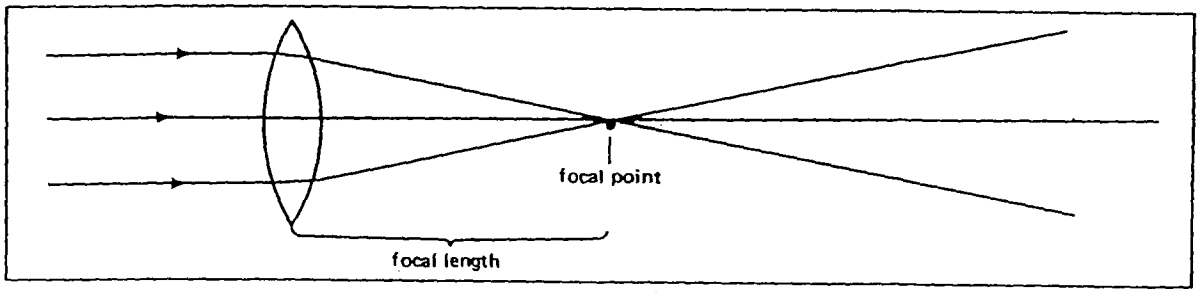


Figure B

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

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

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

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

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.

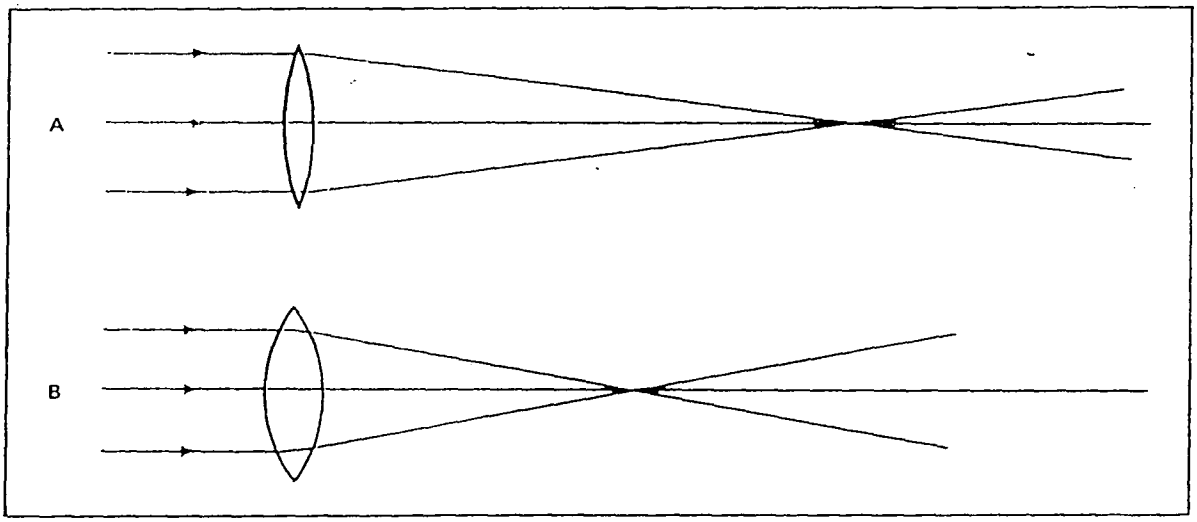


Figure C

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

Now look at Figure D.

Figure D

11. What kind of lens is the boy holding? _____

12. What kind of lens is the girl holding? _____

COMPLETING SENTENCES

Complete the sentences with the choices below. Two of these may be used twice.

refracts	smaller	center
focal length	concave	convex
edge	focal point	larger

1. A lens is a transparent material that _____ light in a definite way.
2. The two main types of lenses are _____ and _____ lenses.
3. A concave lens makes things look _____.
4. A convex lens makes things look _____.
5. The thickest part of a convex lens is its _____.
6. The thickest part of a concave lens is its _____.
7. A _____ lens can form an image on a screen.
8. A _____ lens cannot form an image on a screen.
9. The point where converging light meets is called the _____.
10. The distance between a lens and its focal point is called its _____.

DATE: NAME: CLASS:

CHAPTER 8 REINFORCEMENT

BLM 8-7

Lenses and Light

Goal • Complete this page to show your understanding of how lenses bend light.

What to Do

- Review pages 244 and 245, then answer these questions and complete the diagrams.

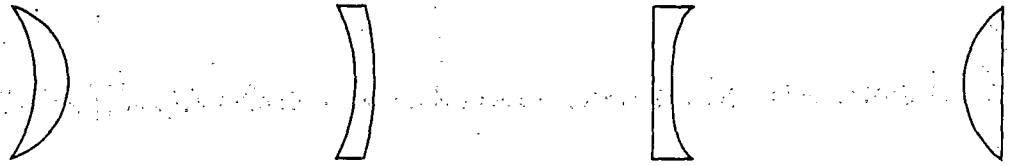
1. Describe a concave lens. _____

_____

2. Light rays _____ when passing through a concave lens.
3. Describe a convex lens _____

_____

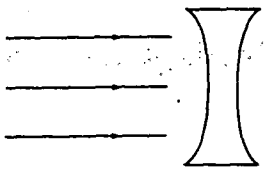
4. Light rays _____ when passing through a convex lens.
5. Sometimes people use the phrase double convex or double concave to describe a lens. They are referring to the shape of each surface. But the shape of the surfaces is not the important thing. To identify concave and convex lenses, it is the thickness of the glass in the middle compared to the thickness at the edges that counts. Classify these strange-looking lenses as convex or concave.



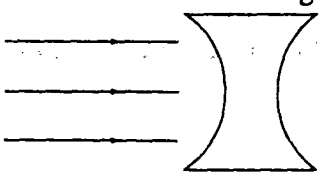
_____ _____ _____ _____

6. Draw the paths of the light through each of the following lenses.

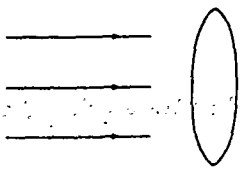
Concave lens with small curve



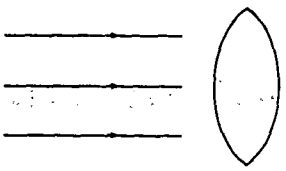
Concave lens with large curve



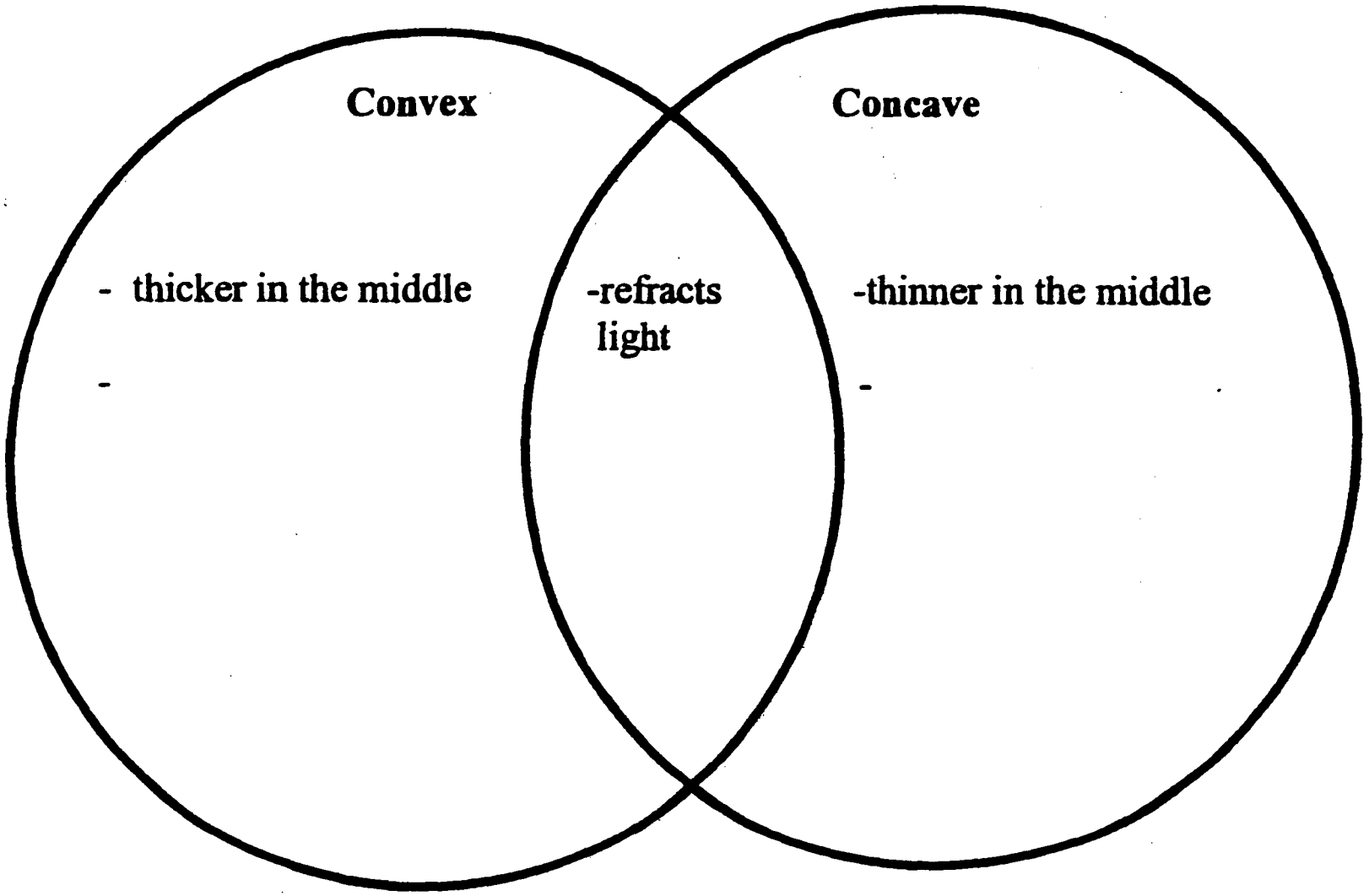
Convex lens with small curve



Convex lens with large curve



Compare/Contrast Concave and Convex Lenses



DATE: NAME: CLASS:

CHAPTER 8 REINFORCEMENT **BLM 8-7**

Lenses and Light

Goal • Complete this page to show your understanding of how lenses bend light.

What to Do

- Review pages 244 and 245, then answer these questions and complete the diagrams.

1. Describe a concave lens. _____

   _____

2. Light rays _____ when passing through a concave lens.
3. Describe a convex lens _____

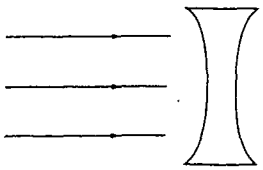
   _____

4. Light rays _____ when passing through a convex lens.
5. Sometimes people use the phrase double convex or double concave to describe a lens. They are referring to the shape of each surface. But the shape of the surfaces is not the important thing. To identify concave and convex lenses, it is the thickness of the glass in the middle compared to the thickness at the edges that counts. Classify these strange-looking lenses as convex or concave.

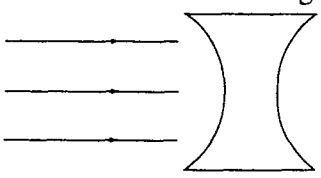
_____ _____ _____ _____

6. Draw the paths of the light through each of the following lenses.

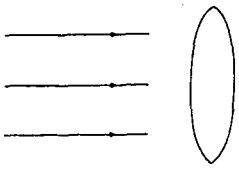
Concave lens with small curve



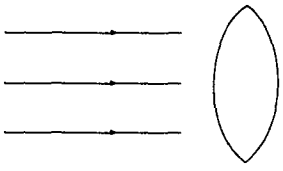
Concave lens with large curve



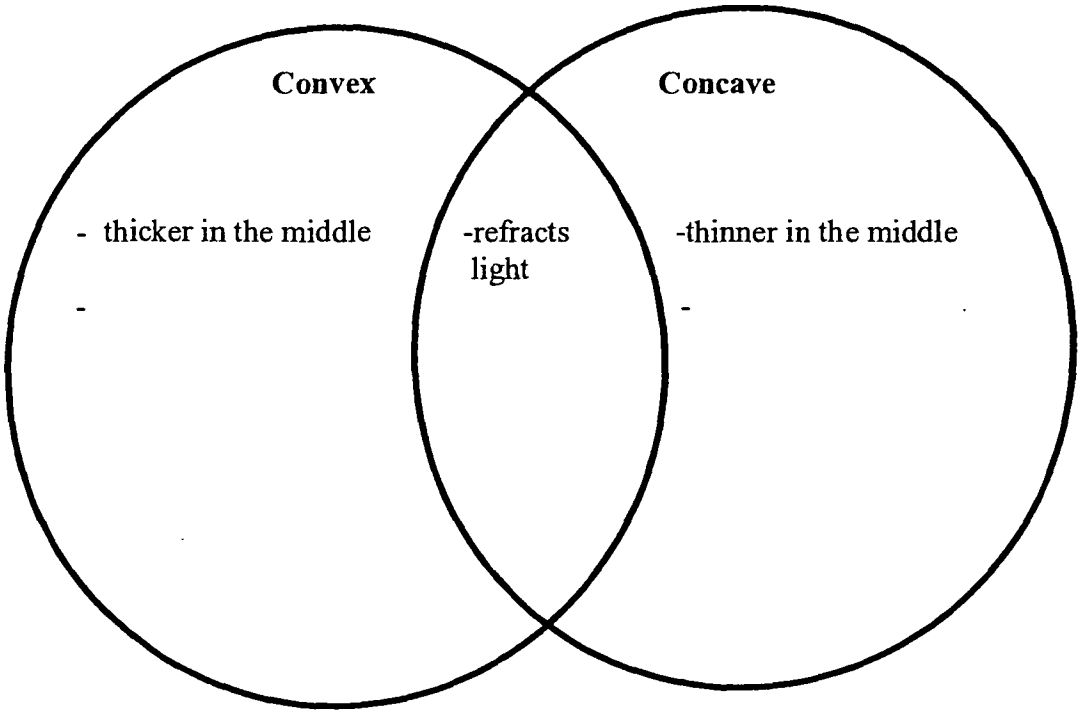
Convex lens with small curve



Convex lens with large curve



Compare/Contrast Concave and Convex Lenses



AIM 21 | How do we see?

At this moment you are reading. Your eyes are open. They must be open. Otherwise, you could not see this page—or anything else.

The eyes are sense organs. They are the organs that allow us to see. The eyes receive and focus light. The light messages then go to the brain. The brain tells us what the light *means*. It tells us *what* we are seeing.

The eye has several transparent parts. Each part *refracts* light that enters the eye. In a normal eye, the light rays converge exactly upon the *retina* [RET nuh].

The retina is at the back part of the eye. It is made up of two kinds of nerve cells: *rods* and *cones*.

- *Rods* are sensitive to *brightness* but not to color.
- *Cones* are sensitive to *color*. Without cones, we would not see color. Everything would be seen as black and white and shades of gray.

The tissues of the retina join to form the *optic nerve*. The optic nerve leads into the brain.

Every part of the eye that refracts light has a "set" focus. Its power does not change. Every part, that is, except the *lens*.

The lens of the eye can change focus. It becomes stronger when we are looking at something close-up. This is important because the eye needs a stronger power for close vision. If the lens of the eye did not change focus, close-up things would seem blurry to most people.

THE EYE

Figure A shows the inside of an eye. It also shows light rays passing through. Study the figure. Then answer the questions.

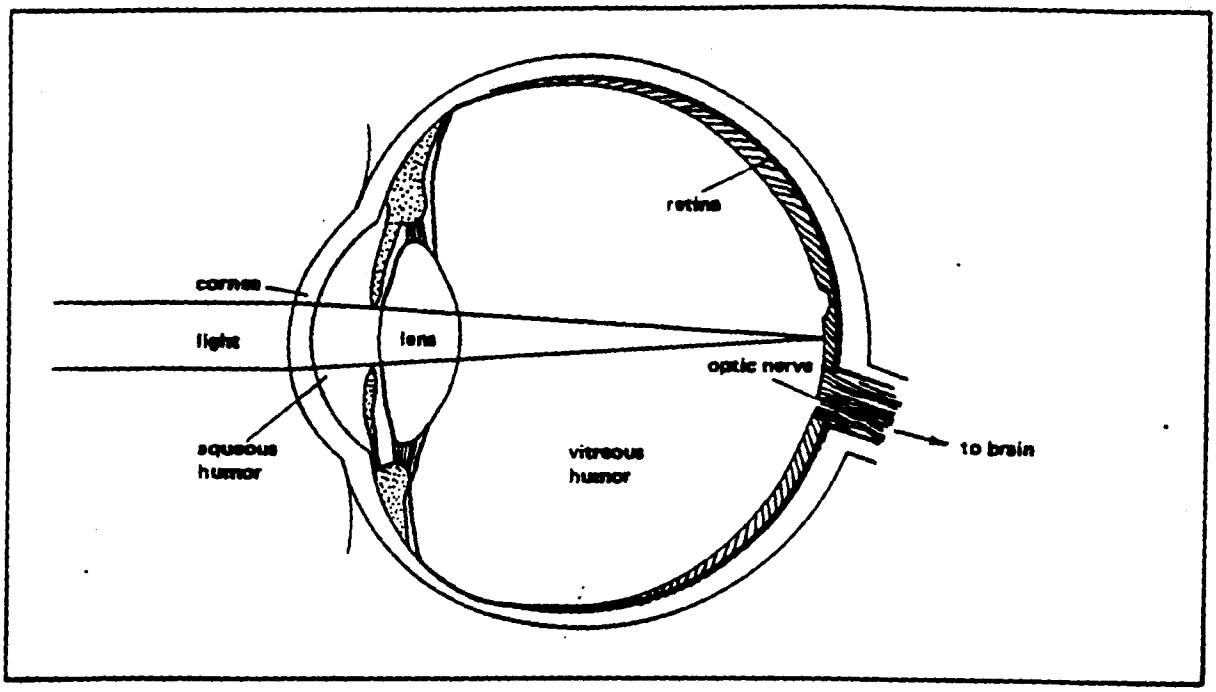


Figure A

1. The first refracting medium of the eye is sometimes called the "window of the eye." What is its name? _____

2. Directly behind the cornea is a transparent liquid. What is its name?

   _____

3. The eye has a thick double-convex tissue. What is it called?

   _____

4. Behind the lens is a transparent jelly-like material. What is its name?

   _____

5. List (*in order*) the refracting parts of the eye:

   _____ _____ _____

   _____

6. In a normal eye, light rays converge upon the _____.

7. The retina is made up of two kinds of nerve cells. Name them.

_____ and _____

8. Rods are sensitive to _____.

9. Cones are sensitive to _____.

10. Retina tissues join to form the _____.

11. The optic nerve leads into the _____.

12. We actually "see" with the _____.

COMPLETING SENTENCES

Complete the sentences with the choices below.

color	converge	refract
lens	eye	brightness
optic nerve	brain	transparent
retina	stronger	

1. The organ that is sensitive to light is the _____.

2. The eye has several _____ parts.

3. The transparent parts of the eye bend, or _____, light.

4. The nerve layer of the eye is called the _____.

5. In a normal eye, light rays _____ upon the retina.

6. The retina is made up of rods and cones. Rods are sensitive to _____.

   Cones are sensitive to _____.

7. Retina tissues join to form the _____.

8. The optic nerve leads into the _____.

9. The part of the eye that can change focus is the _____.

10. When we look at close-up things, the power of the lens becomes

    _____.

MATCHING

Match the two lists. Write the correct letter on the line next to each number.

1. _____	eye	a)	first refracting part of the eye
2. _____	cornea	b)	leads to the brain
3. _____	retina	c)	made up of rods and cones
4. _____	lens of the eye	d)	organ of sight
5. _____	optic nerve	e)	can change its power

IDENTIFYING PARTS OF THE EYE

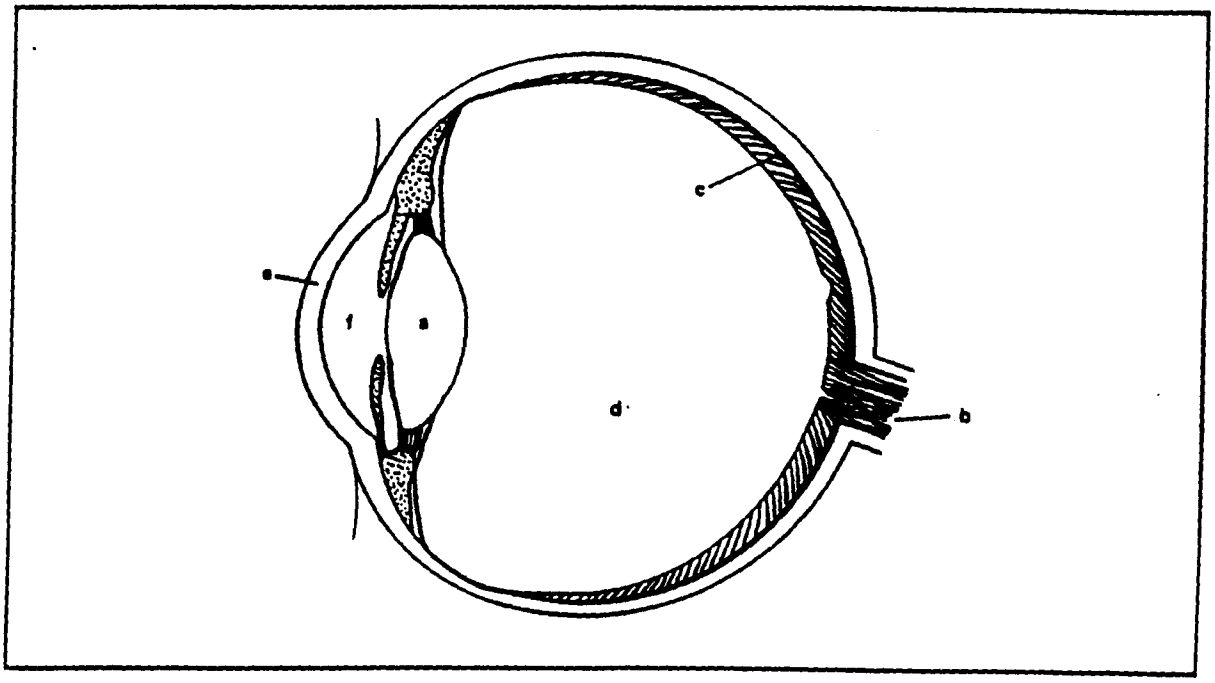


Figure B

Study Figure B. Then, identify these parts of the eye by letter.

1. optic nerve _____
2. cornea _____
3. retina _____
4. aqueous humor _____
5. lens _____
6. vitreous humor _____

REACHING OUT

Five more parts of the eye are listed below. Can you locate them by their descriptions? Write the correct names next to the numbers on Figure C.

Choroid Middle layer of the eye. Rich in blood vessels. Supplies the eye with food and oxygen.

Ciliary Muscle Tiny muscle that changes the shape and power of the lens of the eye.

Pupil Opening of the eye through which light enters.

Iris Gives an eye its color. Opens wider or narrower depending upon the amount of light present.

Sclera Tough, white outer layer of the eye.

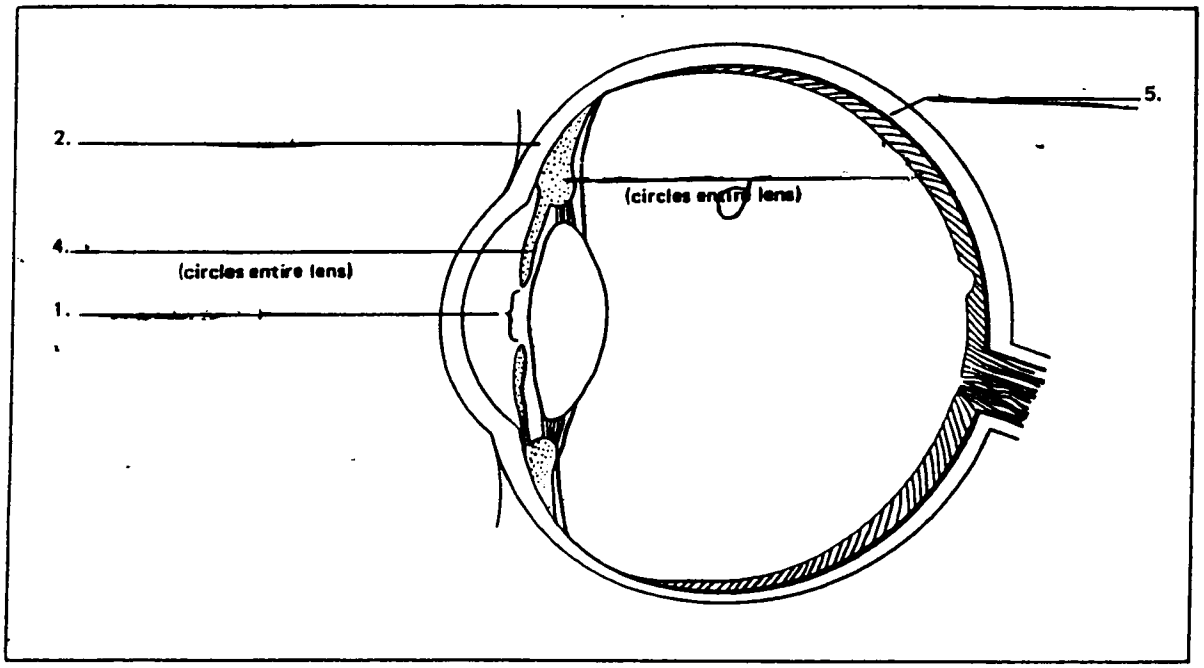
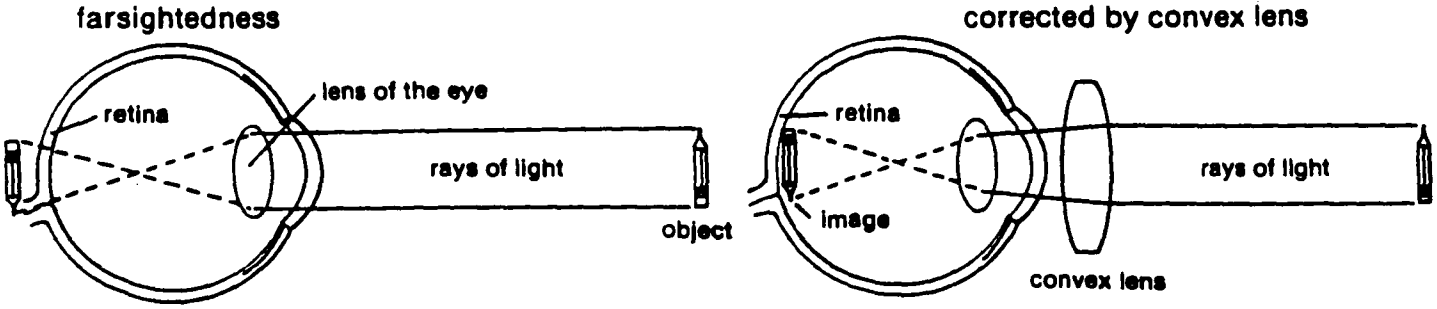


Figure C

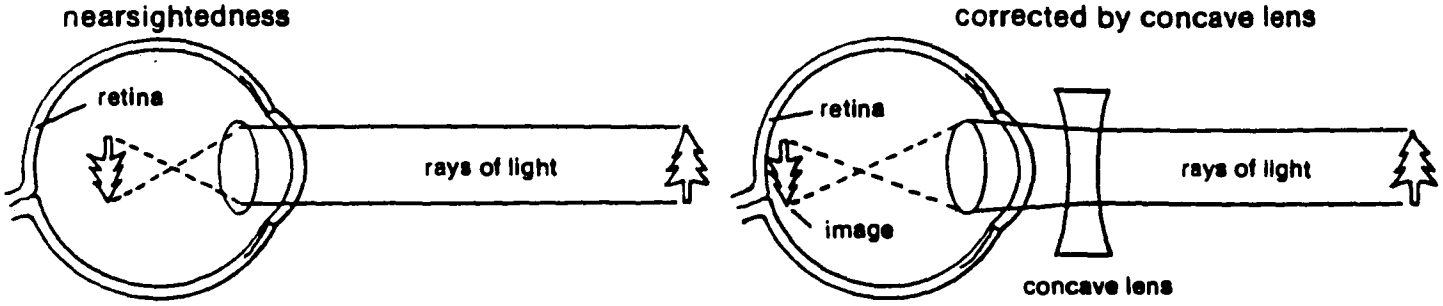
VISION PROBLEMS

Do you know what it means when the school nurse says you have 20/20 vision? It means that you can see something from 20 feet the way the average person should see it. A person with 20/100 vision sees something 20 feet away, the way the average person sees it from 100 feet away.

What can you do if you don't have 20/20 vision? Glasses will usually correct the problem. If you are **farsighted**, you can see things more clearly at a distance than up close. When a person is farsighted, the image falls behind the retina instead of on it. This problem can be corrected by using a convex lens.



If you are **nearsighted**, you see things more clearly up close than at a distance. With this problem the image falls in front of the retina instead of on it. It can be corrected by using a concave lens in your glasses.



ACTIVITY

- Sometimes a person sees different parts of the same object unclearly. This is called **astigmatism**. It, too, can be corrected with special galsses. Explain what causes astigmatism. _____

_____

- What is meant by **colorblindness**? _____

_____

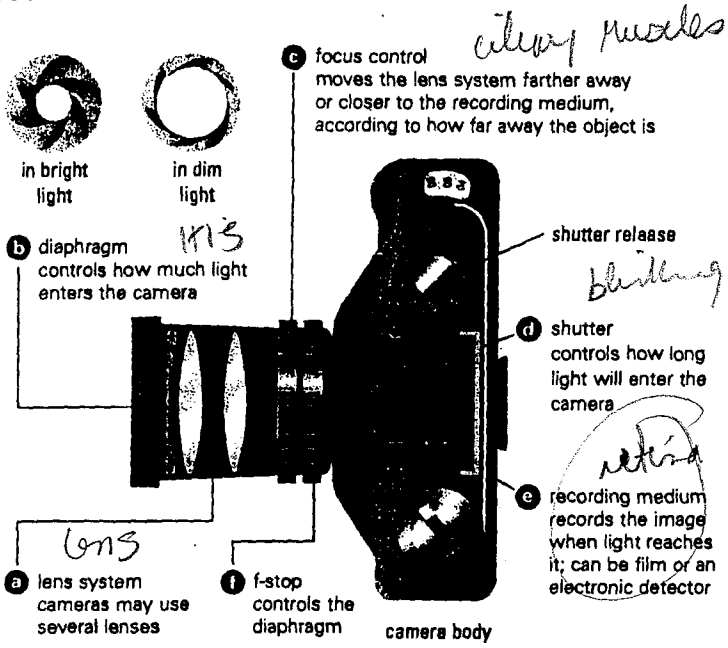
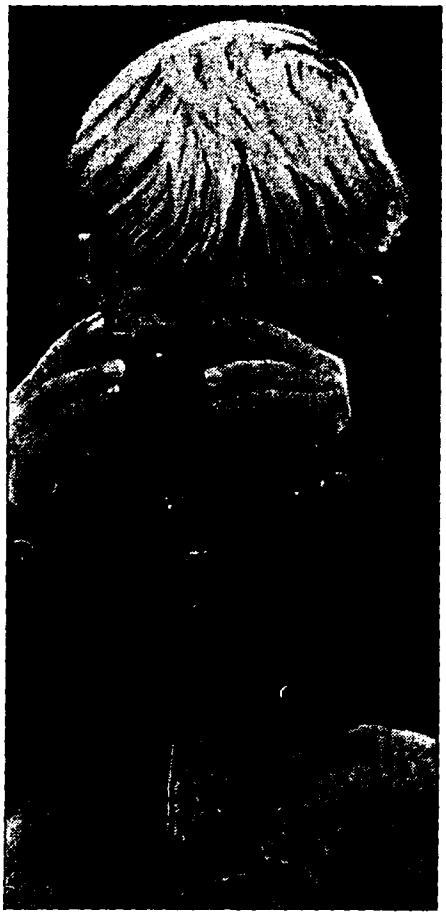


Figure 2
A camera



The Retina: Producing an Image

In the eye, the image is produced on the retina, the light-sensitive layer on the inside of the eye. This area has many blood vessels, nerves, and two types of light receptor cells, called rods and cones because of their shape when examined under a microscope. In most eyes there are about 120 million rods, which are sensitive to the level of light, and about 6 million cones, which are sensitive to colour. The rods and cones transform the light into nerve signals, which are sent to the brain to interpret.

In the camera, the image is produced either on a chemical film, to be developed later, or on a digital device that can be transferred to a computer.

Images in the Eye and the Camera

As you can see in **Figure 3**, in both the eye and the camera, the image is real and inverted. You may think it strange that the images are inverted in your eye, but your brain has had lots of practice flipping them.

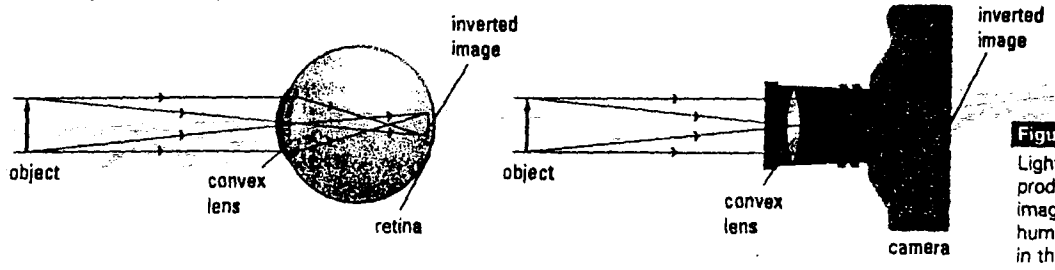


Figure 3
Light and lenses produce real images in the human eye and in the camera.

The Human Eye and the Camera

The human eye is an amazing optical device that allows you to see objects near and far, in bright light and in dim light. Although the details of how we see are complex, we can compare the eye to an ordinary camera.

Figures 1 and **2** show the basic structures of the human eye and of the camera.

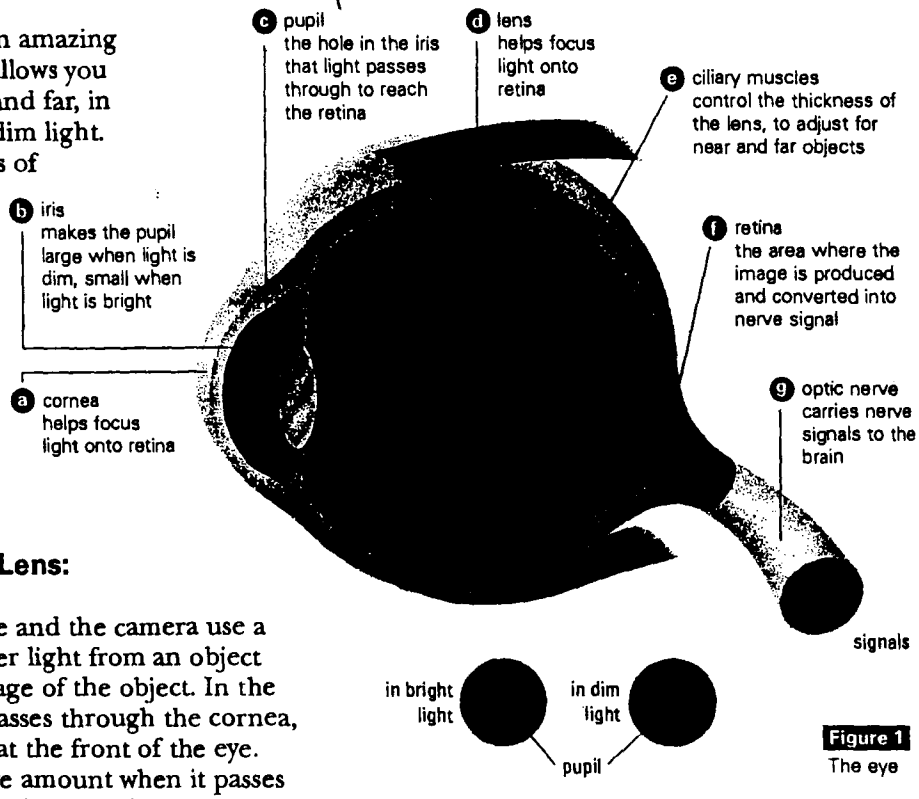


Figure 1
The eye

The Cornea and Lens: Gathering Light

Both the human eye and the camera use a convex lens to gather light from an object and produce an image of the object. In the eye, the light also passes through the cornea, a transparent layer at the front of the eye. Light refracts a large amount when it passes through the cornea, then it refracts more as it passes through the convex lens.

The camera uses a set of lenses to achieve the same effect.

The Iris: Controlling the Amount of Light

You have likely walked into a dark room or theatre before. At first you cannot see well, but your eyes "become adjusted to the dark," and you begin to see better. What actually happens is your pupils become larger. The pupil of the eye is the "window" through which light enters the lens. It looks black because most of the light that enters the eye is absorbed inside.

In a camera the diaphragm has the same function as the iris. Photographers must consider both the diameter of the diaphragm and the exposure time (how long the shutter is open) to get a high-quality photograph.

Ciliary Muscles: Controlling the Focus

If you look at printing held a few centimetres from your eye, you will notice that it is blurred; the printing is out of focus. Your eye can focus clearly on objects as near as about 25 cm and as far away as you can see. When you look at objects far away, the lens is in its normal shape and the ciliary muscles are relaxed. When you look at a close object, the muscles force the lens to become thicker to keep the image focused. As people get older, their lenses and muscles become less flexible, which reduces their ability to control the focus and see close objects clearly.

Instead of changing the shape of the lens, the camera moves the whole lens system to focus. The lens system can be moved back and forth to be the correct distance from the recording medium to produce a clear image.

The Eye and the Camera

Fill in the chart below with each part of the eye's function and the part of the camera that corresponds to it.

Function	Eye	Camera
	pupil	
	iris	
	lens	
	retina	
	cornea	

Both parts of the eye and parts of the camera can be _____ .

Both also deal with _____ .

On the back of this worksheet, state at least three differences between the eye and a camera.

ACTIVITY Find your blind spot.

If an image falls on this part of the retina, the brain does not receive any information about it and you do not see it. To find your blind spot, hold this paper about 12" from your face. Close your right eye and look at the bird with your left eye. Move the paper back and forth until the bird disappears. Then test your right eye by closing your left eye and looking at the nest with your right eye.

How do you think the blind spot affects your vision? _____

_____