2 Eye and Ear

Our environment is subjected to frequent changes. Our eyes, ears, nose, tongue and skin perceive these changes that occur in our environment. Let us study about the structure and functions of the eye and the ear.

2.1 Structure and function of the human eye

The eye is the optical sensory organ in our body. Let us take a look at the structure of the eye to study how we see things.

Activity 2.1

You will need :- A model of the eye in the laboratory or a diagram

Method :-

- Observe the eye model or the diagram well.
- Identify the parts of the eye.
- Get the help of a labelled diagram of the eye.

Figure 2.1 - A model of the eye

A cross section of human eye is given by the figure 2.2.

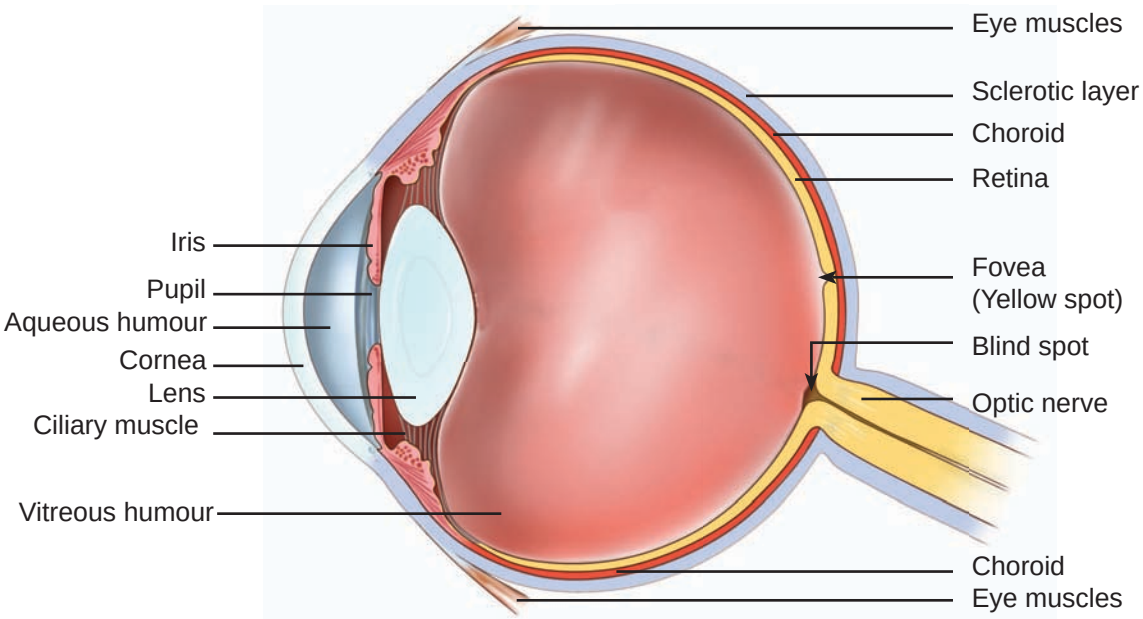


Figure 2.2 - A cross section of human eye

Eyes are situated inside the orbits in the skull (figure 2.3). Eye are fixed with six eye muscles in the orbits (figure 2.4).

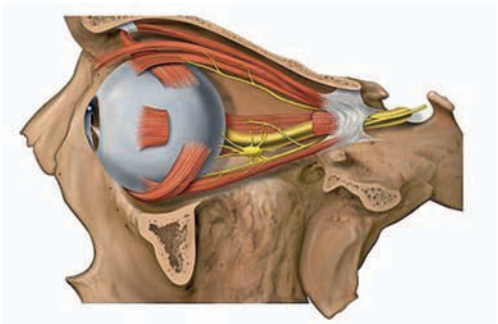


Figure 2.3 - Location of eye inside the orbit

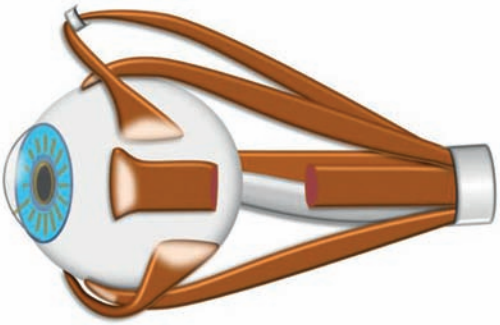
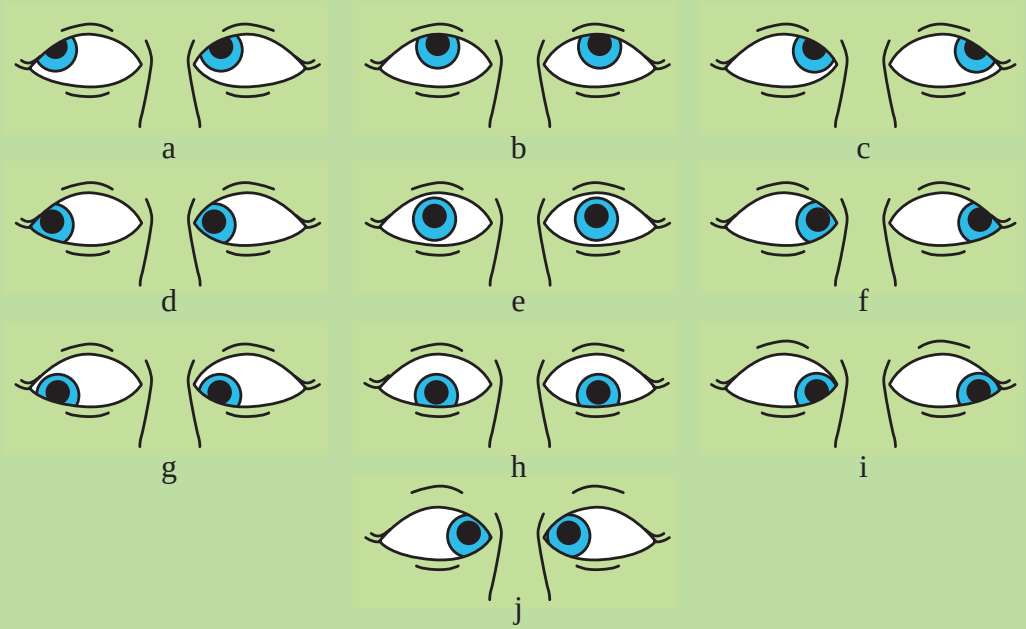


Figure 2.4 - Connection of eye with eye muscles

Therefore, eye ball can move in vertical plane, horizontal plane and circular plane.

For extra knowledge



b, e, h - To move eye ball in vertical plane.
d, e, f - To move eye ball in horizontal plane.
a, d, g, h, i, f, c, b, j - To move eye ball in circular plane.

Hence, human eye has the ability of seeing a broad area. Which means widening of optic region.

The table 2.1 shows the information about the main parts of the eye.

Table 2.1 - Information about the major parts of the human eye

Part of the structure	Information
Sclerotic layer	▪ Tough, white outer most layer of the eye ▪ Light do not penetrate through it.
Cornea	▪ The sclerotic layer in front of the iris becomes thin, transparent and forms the cornea
Choroid layer	▪ Inside the sclerotic layer is the choroid layer ▪ Supplies blood to the eye
Retina	▪ Inside the Choroid layer is the retina ▪ The light sensitive rod cells and cone cells are located in this layer.
Aqueous humour	▪ A transparent watery liquid. ▪ Fills the space between the lens and cornea.
Lens	▪ Transparent biconvex lens that has the ability to change its curvature ▪ Focuses the images on retina.
Iris	▪ Controls the amount of light entering the eye
Pupil	▪ The hole in the centre of the iris. ▪ It allows light to enter and pass through the lens.
Ciliary muscle	▪ Supports to hold the lens ▪ Helps to change the curvature of the lens, when necessary.
Vitreous humour	▪ A transparent Jelly-like substance, which fills the rear cavity of the lens. ▪ Helps to maintain the spherical shape of the eye.
Fovea/Yellow spot	▪ The sensitive part of the retina, where the sharp images formed.
Blind spot	▪ The area of the retina, where light sensitive cells not located. ▪ Though, light is focused no vision is possible.
Optic nerve	▪ The nerve that connects the eye and the brain. ▪ Convey the visual stimulus from the retina to the brain for interpretation of images.

Let us see how the eye perceives visionary senses.

Let us inquire the way that our eye functions to give us sight. To see an object clearly, light rays must be entered to the eye from the object. The rays refract through the lens and converge on to the retina, forming an inverted image. Then, the nerve endings on the retina get stimulated and send the message about the image to the brain through optic nerve. Optical area of brain interprit it as an upright one.

Eye lens is convex. Let us engage in the activity 2.2 to study the refraction of light through convex and concave lenses.

Activity 2.2

You will need :- A convex lens, a concave lens, a parallel beam of light made by using a torch or by reflecting the sunlight using a mirror, a comb

Method :-

- Let the parallel beam of light fall on the convex lens and observe the refracted rays.
- Let the parallel beam of light fall on the concave lens and observe the refracted rays.
- Draw the path of the light in both situations in your note book.

The path of a parallel beam of light directed towards a convex lens after refracting through the lens is depicted in the figure 2.5. After refraction the light rays get converged to a point.

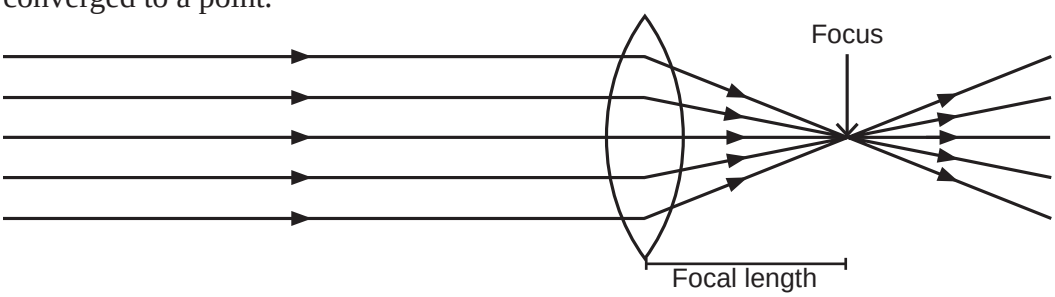


Figure 2.5 - Refraction of parallel beam of light through convex lens

The point that collects light rays in front of a convex lens is called the focal point of the lens. The distance between lens and focus is **focal length.**

A parallel beam of light falls on a concave lens after refraction through the lens get diverged as the figure 2.6.

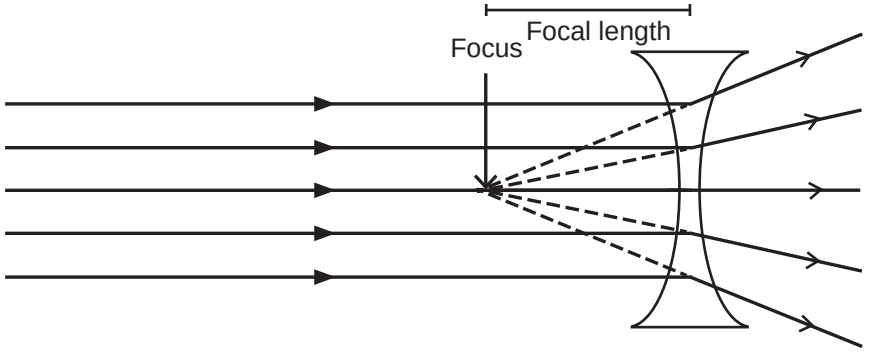


Figure 2.6 - Refraction of parallel beam of light through concave lens

After the refraction the light rays can be observed to be diverged, as shown the figure 2.6. Here the rays after refraction appear to come from a point called focus.

An image of an close object forms far from the convex lens, while far object forms an image, close to the lens. Let us engage in activity 2.3 to study this concept.

Activity 2.3

You will need :- A convex lens, a candle, a box of matches, lens holder, a screen (you can prepare a screen by covering a lens holder or a small box with a white paper)

Method :-

- Fix the convex lens to the lens holder. Using the lens get a clear image of a distant object on the screen.
- Light the candle in front of the lens and get a clear image on the screen.
- Measure the distance between the lens and the image (image distance) in both cases, and compare.

You can confirm that the image distance is more when the object is located close by than it is located far away.

But, considering the eye the distance from the lens to the retina (image distance) cannot be changed. Then, how can we clearly see the objects close by and far away? The lens of the eye has the ability to increase or decrease its curvature to the required size.

Let us do the activity 2.4 to study about the image formation of a distant object and nearby object without changing the image distance.

Activity 2.4

You will need :- A convex lens with a less curvature, another convex lens with a higher curvature, candle, lens holder, screen

Method-

- Fix the convex lens with less curvature to the lens holder and get a clear image of a distant object on to the screen (figure 2.7 a).
- Fix the convex lens with a higher curvature to the lens holder without changing the distance between the lens and the screen. Now get a clear image of the lit candle on to the screen (figure 2.7 b).

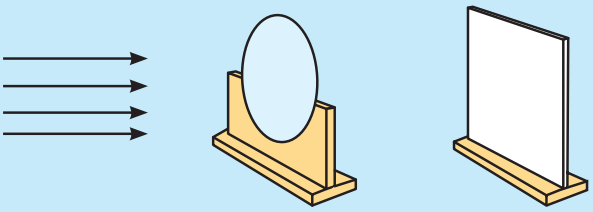


Figure 2.7 a

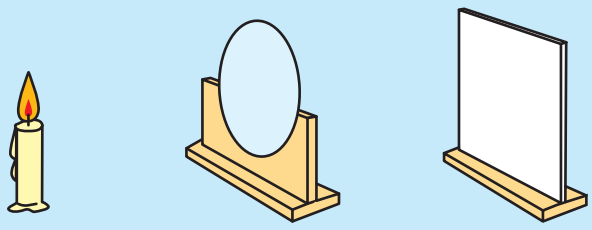


Figure 2.7 b

The focal length is comparatively high in low-convex lenses (lens with a less curvature) while the focal length is relatively low in higher convex lenses (lenses with a higher curvature).

Figure 2.8 a - Convex lens with less curvature

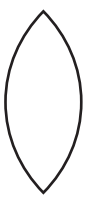


Figure 2.8 b - Convex lens with high curvature

Figure 2.8

According to the activity 2.4 it can be concluded as follows.
To get a clear image without changing the image distance,

- The curvature of the eye lens should be reduced for a distant object.
- The curvature of the eye lens should be increased for a close object.

Assignment 2.1

Make a water lens using necessary items.

By increasing or decreasing the curvature of the lens get clear images of a lit candle placed in different places, without changing the image distance.

- **Ray diagram for an image formed of far object on the retina of eye (figure 2.9).**

The rays that reach from far object, can be considered as parallel rays.

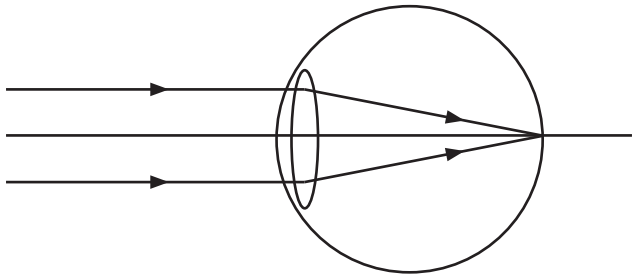


Figure 2.9

The rays that reach the eye from far object, get refracted through the lens and converged onto the retina making image on it.

- **Ray diagram for an image formed of close object on the retina of eye (figure 2.10).**

The rays that reach from close object, can be considered as diverged rays.

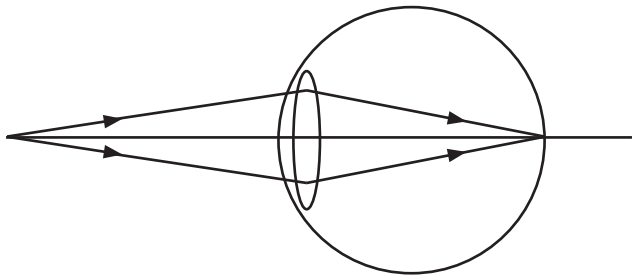


Figure 2.10

The rays that reach the eye from close object, get refracted through the lens and converged onto the retina making an image on it.

2.2 Defects of vision

Two eye defects can be identified in vision due to the eye ball becoming short or long and inability to adjust the focal length of the eye lens to desired level.

- Long sight (hypermetropia)
- Short sight (myopia)

Long sight (hypermetropia)

A person having this defect is able to see far objects clearly, but close objects become unclear. This happens because either the inability to increase the curvature of the eye lens or the eye ball being too short. This defect can be corrected by using a convex lens.

Let us look at how the vision of a person suffering from long sight takes place.

- The person can focus the rays coming from a distant object on the retina to form a sharp image. So, that he can see distant objects clearly (figure 2.11).

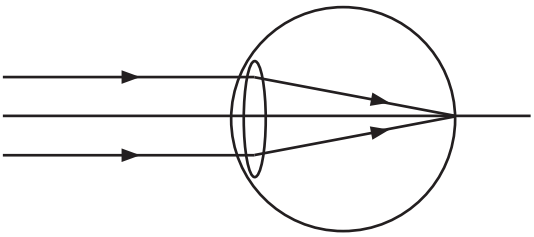


Figure 2.11

- The light rays from the nearby object cannot be brought to focus on the retina to give a distinct image. In this case the image is formed behind the retina, as the rays get focused behind the retina (figure 2.12).

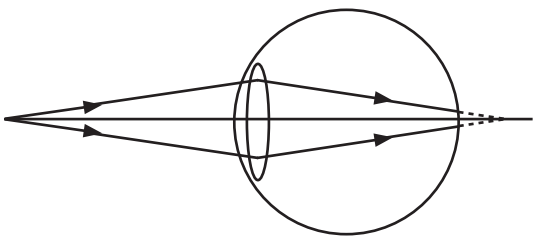


Figure 2.12

Correcting the long sight

- This defect can be corrected by using a convex meniscus lens. The convex meniscus lens receives the light rays and converge them. The eye lens converges the rays again to focus the image at the retina.

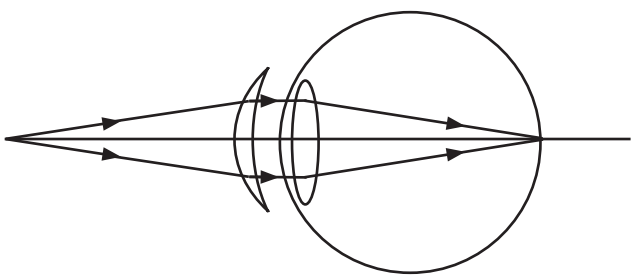


Figure 2.13 - Long sight and its correction

Let us do the activity 2.5 to understand what happens after long sight is corrected.

Activity 2.5

You will need :- Two convex lenses, candle, screen

Method :-

- Using one convex lens get a clear image of a distant object on the screen.

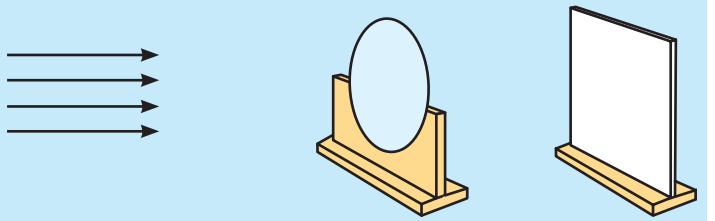


Figure 2.14 a

- Get a clear image of a somewhat far object on the screen.

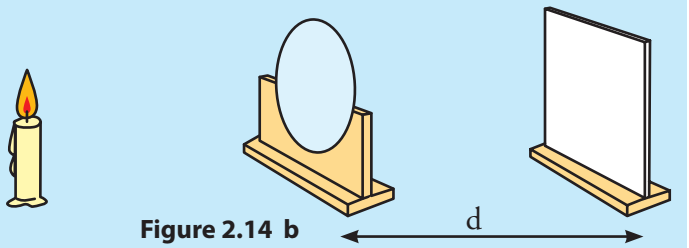


Figure 2.14 b

- Light the candle in front of the lens **without changing the distance between the lens and the screen.** Observe the blurred image.

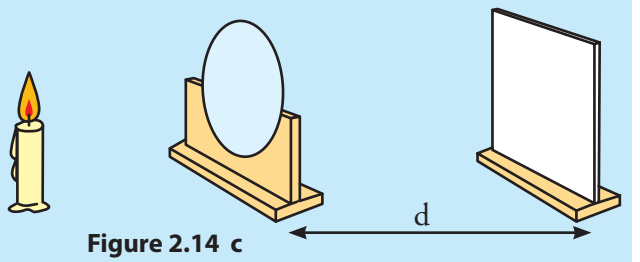


Figure 2.14 c

- Place the other convex lens between the first lens and the screen. Move it until a clear image of the candle is focused on the screen.

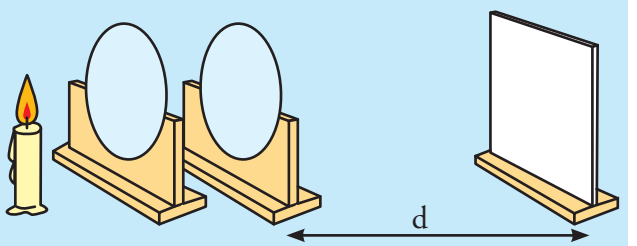


Figure 2.14 d

From the activity 2.5 you can understand that when nearby objects cannot be seen clearly, convex lenses can be used to make the image clear.

Short sight (myopia)

A person sees nearby objects clearly while distant objects appear blurred. This defect arises because of the inability to reduce the curvature of the eye lens or elongation of the eye ball. This defect can be corrected by using a concave lens.

Let us look at how the vision of a person suffering from short sight takes place.

- The rays coming from close objects can be focused on the retina. So, the close objects can be seen clearly (figure 2.15).

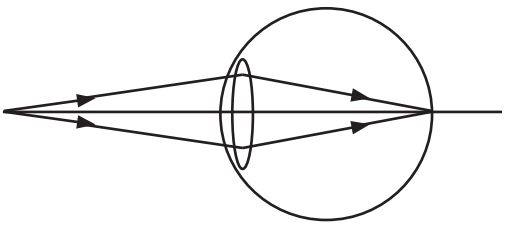


Figure 2.15

- The rays coming from distant objects are focused in front of the retina. So, the image of a distant object is formed in front of the retina and cannot be seen clearly (figure 2.16).

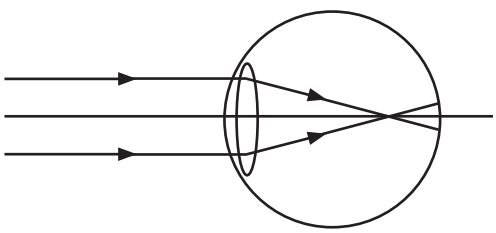


Figure 2.16

Correcting the short sight

- This defect can be corrected by using concave meniscus lens. The rays from the object are diverged through the concave meniscus lens and the eye lens converge them to a point on retina to make the image clear.

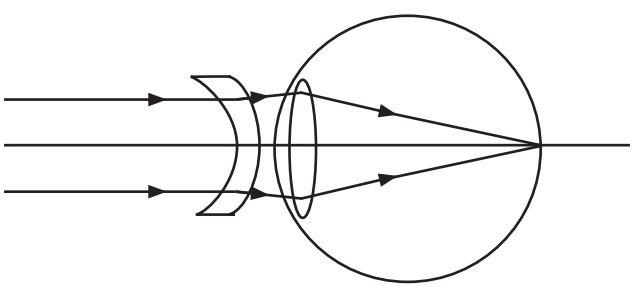


Figure 2.17 - Short sight and its correction

Let us do the activity 2.6 to understand what happens after correcting the short sight.

Activity 2.6

You will need :- A convex lens, a concave lens, candle, screen

Method :-

- Light the candle in front of the convex lens and get a clear image of it on the screen.

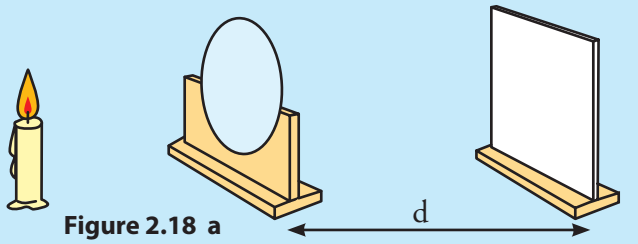


Figure 2.18 a

- When the candle is kept far away without changing the distance between the lens and the screen (distance "d") can get a blurred image of a distant object on the screen.

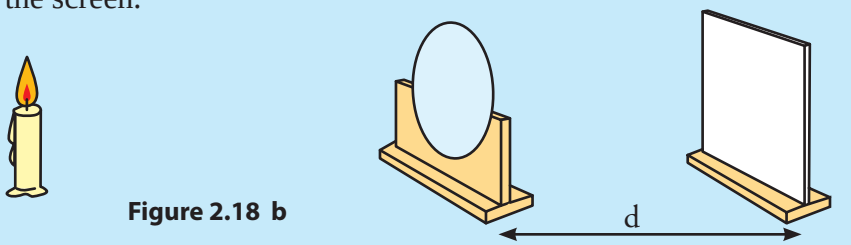


Figure 2.18 b

- Place a concave lens in front of the convex lens and move it till a clear image of the candle is formed on the screen.

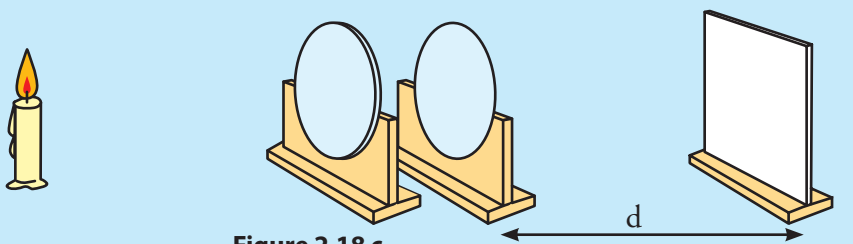


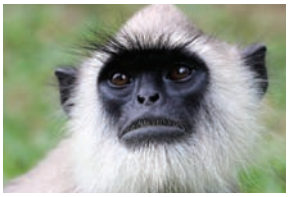
Figure 2.18 c

From the activity 2.6 it can be understood that when distant objects cannot be seen clearly concave lenses can be used to get a clear image of a distant object.

Binocular vision and stereoscopic vision

The eyes of human, monkey, 'Rilava'/'Mandi', chimpanzee, gorilla and loris are located in front position of the skull (figure 2.19). So, there is a greater chance of seeing the same area with both eyes.

Human



Monkey

'Rilava' / 'Mandi'

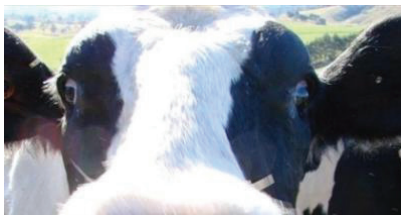
Chimpanzee

Gorilla

Loris

Figure 2.19

Mammals such as cattle, dog, tiger have no ability to look at the same area using both eyes (figure 2.20). But, they have the ability to look more areas separately using the each eye.



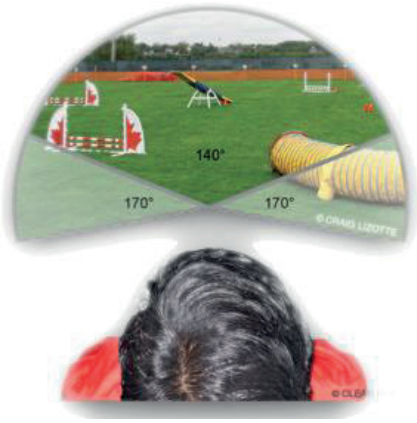
Cattle

Dog

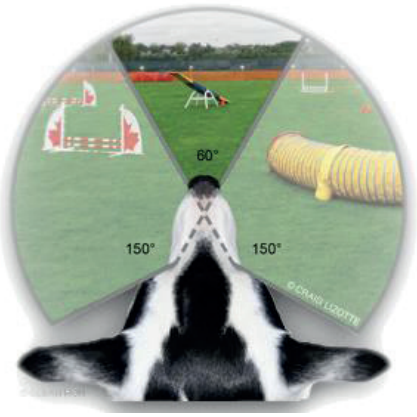
Tiger

Figure 2.20

The ability to maintain visual focus on an object with both eyes creating a single visual image is known as **binocular vision.** The human has a broader range of a binocular vision.



The range of binocular vision of man



The range of binocular vision of dog

Figure 2.21

Let us do the activity 2.7 to identify your range of binocular vision.

Activity 2.7

Method :-

- Keep the face straight and look forward.
- Do the following things without moving the face.
- Stretch your hands and fold your fingers.
- Straighten the thumb right upwards.
- Close your left eye and move your left hand in the horizontal plane to the left until you cannot see the thumb.
- Keep the left hand in the same position and close your right eye. Now move your right hand in the horizontal plane to your right until you can't see the thumb.
- Now look at both thumbs using the both eyes.

Your eyes can see the objects which lie in the range of the stretched hands. It is your binocular range. But, when the both eyes are opened the objects seen to the left of the left hand can be seen only by the left eye. Similarly the objects to the right of the right hand can be seen only by the right eye.

Due to the binocular vision human has got the **stereoscopic vision** and the ability to determine the distance of an object. stereoscopic vision means the ability of eye to determine the depth of an object or the height of it. Let us do the activity 2.8 to study this further.

Activity 2.8

You will need :- A ball point pen

Method :-

- Hold the clip of the pen keeping its hole upwards in a distance when you stretch the hands to your front.
- Close one eye and insert the pen into the clip.
- Insert the pen again into the clip using both eyes.
- Compare the difference of ease, in both situations.

It is easier to insert the pen into the clip by seeing through both eyes rather than seeing through one eye. This is because of the stereoscopic vision of the eye.

2.3 Eye diseases

There are two common eye defects can be identified today. They are;

- Cataract
- Glaucoma

Cataract

A cataract is a cloudiness or opacity in normally transparent crystalline lens of the eye. It is because of the denaturing of proteins in the eye. Then, eye lens turns to milky colour.

The lens of a healthy eye is transparent The lens of a diseased eye is not transparent

Figure 2.22

Cataract prevents the light rays coming from an object focusing properly on the retina. Then, all the objects are seen blurred.

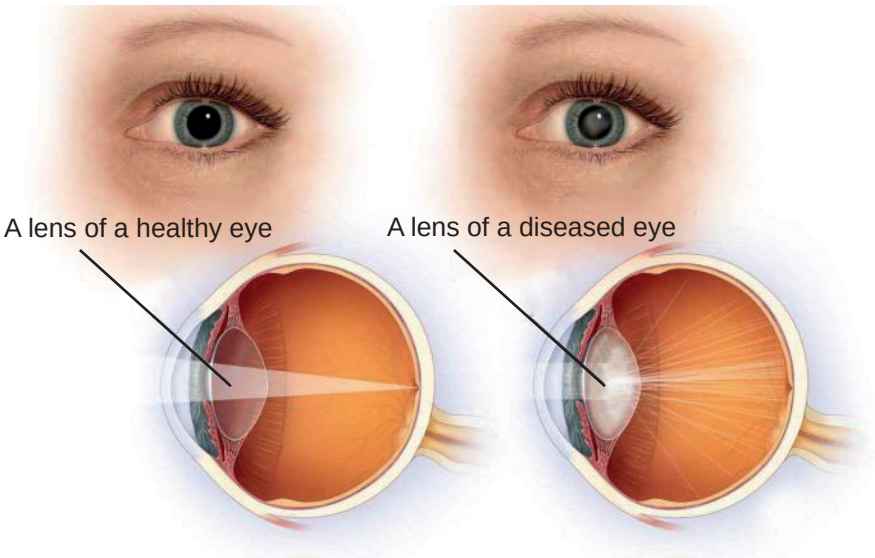


Figure 2.23

A healthy eye sees an object clearly — The diseased eye sees the objects blurred

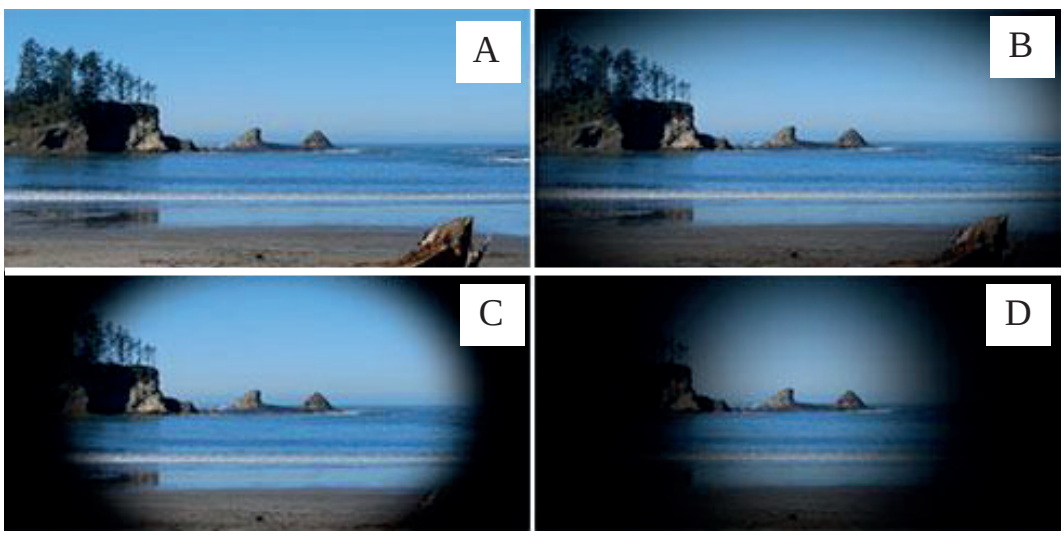
Figure 2.24

Generally, cataract may occur with age and genetical factors. It is believed that ultra violet rays reach the Earth through holes of the ozone layer affect towards the occurrence of cataracts in eye.

Glaucoma

Glaucoma is a disease that gradually reduces the visual range of the eye and leads for blindness due to damage of the optic nerve. By detecting at the first stage further increase of glaucoma can be controlled. Glaucoma is usually the result of high blood pressure inside the eye. A person with diabetes has an increased risk of developing glaucoma. The damage caused to the eye, cannot be reversed again.

The figures A, B, C and D shows how a glaucoma patient loses his vision gradually.



A - healthy eye sees the objects clearly

B - first stage of glaucoma

C - middle stage of glaucoma

D - final stage of glaucoma (leads to vision loss or blindness)

Figure 2.25

Eye infections

In addition to above mentioned diseases, eyes can be infected by viruses. Reddening of eye, secretion of tears are the symptoms. The disease spreads through insects ('Konduruwa') and by contact. This condition is known as "sore eyes". It can be cured by medical treatments (figure 2.26).

Figure 2.26

Precautionary measures should be followed to prevent health problems and possible defects of the eye. Such precautions are given below.

- Protect your eyes from harmful light rays
- Do not look at the sun directly at a solar eclipse and necessary safety methods should be used to look at the sun in such situations
- Be sure to wear safety glasses when do welding
- Do not use eye drops or any other liquids into the eye without medical advice
- Do not use someone else's spectacles
- When using sun glasses follow medical advices
- Should care for personal hygiene
- Do not watch television and use computers continuously or take precautions to minimize the damage

2.4 Structure and function of the human ear

Audio sensory organ of the body is the ear. Let us take a look at the structure of the ear.

Activity 2.9

You will need :- A model of the human ear in the laboratory or a diagram

Method :-

- Observe the model or the diagram well.
- Identify the parts of the human ear.
- Get the help of named diagram of the human ear.

Figure 2.27 - A model of the human ear

A diagram of the human ear is given by figure 2.28.

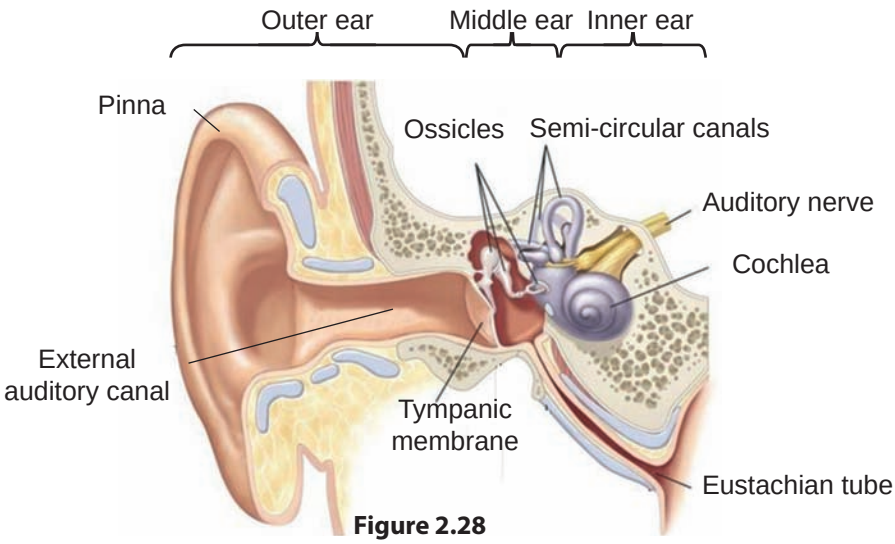


Figure 2.28

Information about the major parts of the human ear is given in the table 2.2.

Table 2.2 - Information about the major parts of the human ear

Area	Part of the organ	Information
Outer ear	Pinna/ear lobe	• A cartilaginous organ. • Directs sound waves towards the auditory canal.
	External auditory canal	• Direct the sound to tympanic membrane.
	Tympanic membrane	• Vibrates in response to the sound wave and acquires the auditory senses.
Middle ear	Ossicles	• Three bones named malleus, incus and stapes. • Sound related vibration is transmitted to the cochlea.
	Eustachian tube	• An open tube connected to pharynx. • Controls the pressure on either sides of the tympanic membrane
Inner ear	Cochlea	• The nerve endings of the auditory nerve is connected to cochlea. • Auditory senses are transmitted to the auditory nerve.
	Auditory nerve	• Auditory senses are taken to the relevant part of the brain. • The sound is interpreted by the relevant part of the brain.
	Semi-circular canal	• Contributes to maintain the balance of body.

Let us see how the ear perceives auditory senses.

Do the activity 2.10 to demonstrate how a membrane is vibrated according to a sound.

Activity 2.10

You will need :- Two funnels, sheath of a balloon, 2m length rubber tube, thread, a tuning folk

Method :-

- Tighten well the balloon sheath to the mouth of a funnel.
- Join the two funnels to the open ends of the 2m length rubber tube.
- Keep the funnel with the balloon sheath to one of the student's ear and vibrate the tuning folk near the other funnel.
- Report your observations.

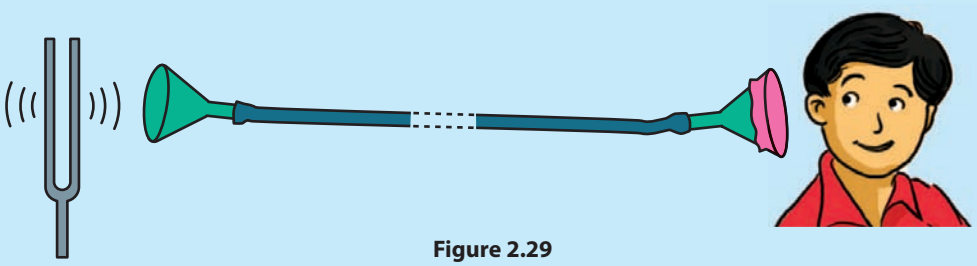


Figure 2.29

When the folk is vibrated the rubber sheath too vibrates and hear the sound better. Similarly, correspond to the sound wave the tympanic membrane vibrates.

The sound waves created by the vibrations of the objects in the external environment, travels to tympanic membrane along the external auditory canal. The tympanic membrane is vibrated accordingly. The vibrations are then transmitted to cochlea through ossicles. The nerve endings connected to cochlea take the auditory senses to the auditory nerve. The auditory nerve transmits the impulse to the relevant part of the brain. The sound is interpreted by the auditory area of the brain.

2.5 Defects of ear

Disorders such as impaired hearing, deafness, hardening of ossicles may occur in ears while living or from the birth. It is also said that people who are deaf from birth are dumb too. Hearing aids can be used as a remedy for loss of hearing.

You know that 20 Hz - 20 000 Hz is the audibility range of the human ear. There is also a limited intensity of sound in this range that the ear can tolerate. Sounds beyond this range can damage the ear.

Necessary precautions should be taken to protect the ear.

- Avoid inserting foreign objects into the ear
- Refrain exposing to loud noises
- Do not put any medicines for the ear without medical advice
- Avoid diving in deep waters without wearing safety equipments (As pressure is very high in deep water)
- Avoid slapping the ear and dragging by the ear lobe

Figure 2.30

Assignment 2.3

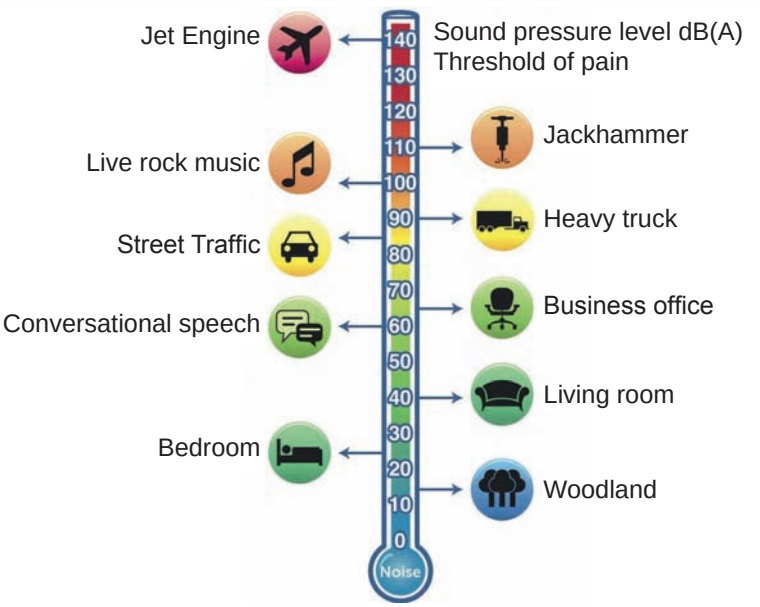
- Using suitable materials make a model of a stethoscope.

Figure 2.31

Assignment 2.4

- Prepare ten short questions on eye and ear to conduct a quiz competition.

For extra knowledge



Summary

- Optical sensory organ of the body is the eye.
- Images that are real, inverted and smaller than the object formed on the retina is interpreted by the brain. This is known as vision.
- Binocular vision of human is important to determine the distance of an object and stereoscopic vision.
- The most common defects of vision are long sight and short sight.
- Long sight can be corrected by using a convex lens while short sight can be corrected by using a concave lens.
- Today's most frequent eye diseases are cataract and glaucoma.
- To maintain a healthy vision for a long period of time necessary precautions should be taken to protect the eye.
- Audio sensory organ of the body is the ear.
- Sound waves vibrate the tympanic membrane and the cochlea. This results the stimulation of the nerve endings of the cochlea.
- This auditory impulse is carried to the brain by the auditory nerve and the relevant part of the brain interpret the sound. This is known as hearing.
- The semi-circular canals contribute to maintain the balance of body.
- Hardening of ossicles, impaired hearing and deafness are some disorders of hearing.
- The range of audibility of the human ear between 20 Hz - 20 000 Hz.
- The sounds of higher intensities may damage the ear.
- Necessary precautions must be followed to protect the ear.

Exercise

01) Select the correct or most suitable answer.

1. The part that an image focuses on the human eye is
   1. Vitreous humour
   2. Eye lens
   3. Iris
   4. Retina

2. The defect that close objects can be seen clearly, but distant objects can be seen blurred is
   1. Long sight
   2. Glaucoma
   3. Cataract
   4. Short sight

3. The organ in the ear that maintain the balance of body is
   1. Cochlea
   2. External auditory canal
   3. Ossicles
   4. Semi-circular canal

4. Following are some statements that a student wrote about the ear and its functions.

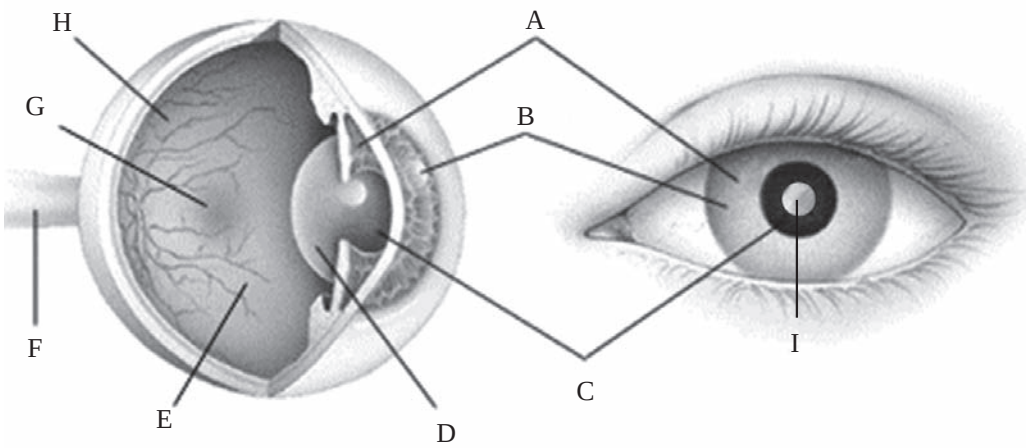
a. Ear lobes are cartilaginous.
b. Cochlea transmits auditory senses to the auditory nerve.
c. Ossicles are located in the external auditory canal.

1. a and b only
2. b and c only
3. a and c only
4. a, b and c

5. The range of audibility of the human ear is

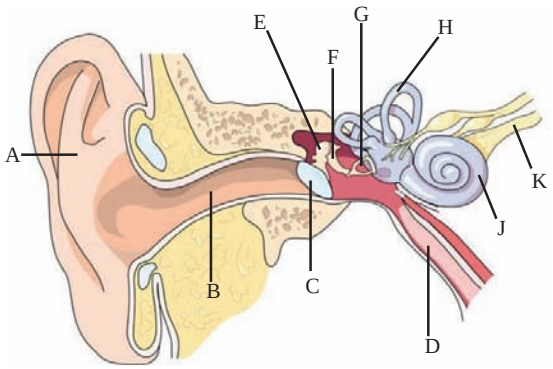
1. **2** Hz - **20 000** Hz
2. **20** Hz - **20 000** Hz
3. **20** Hz - **200 000** Hz
4. **200** Hz - **20 000** Hz

02) Following figure shows the structure of human eye.



Write down the names and functions of each part in the eye denoted by English letters A to H.

03) Using given English letters mention the path of the auditory impulse that strat from ear to the brain.



Technical Terms

Long sight	-	දුර දෘෂ්ටිකත්වය	-	சேய்மைப் பார்வை
Short sight	-	අවිදුර දෘෂ්ටිකත්වය	-	அண்மைப் பார்வை
Binocular vision	-	ද්විනේත්‍රික දෘෂ්ටිය	-	இருவிழிப்பார்வை
Stereoscopic vision	-	ත්‍රිමාණ දෘෂ්ටිය	-	முப்பரிமானப் பார்வை
Retina	-	දෘෂ්ටිවිතානය	-	விழித்திரை
Optic nerve	-	දෘෂ්ටික ස්නායුව	-	பார்வை நரம்பு
Cornea	-	ස්වච්චය	-	விழிவெண்படலம்
Iris	-	තාරාමණ්ඩලය	-	கதிராளி
Pupil	-	කණීනිකාව	-	கண்மணி
Fovea	-	කහ ලපය	-	மஞ்சளிடம்
Blind spot	-	අන්ධ බින්දුව	-	குருட்டிடம்
Convex lens	-	උත්තල කාචය	-	குவிவு வில்லை
Concave lens	-	අවතල කාචය	-	குழிவு வில்லை
Cataract	-	ඇසේ සුදෑ	-	கட்காசம்
Glaucoma	-	ග්ලූකෝමාව	-	குளுக்கோமா
Tympanic membrane	-	කර්ණපටහ පටලය	-	செவிப்பறை மென்சவ்வு
Cochlea	-	කර්ණ සංඛය	-	நத்தைச்சுருள்
Ossicles	-	කර්ණ අස්ථිකා	-	செவிச் சிற்றென்புகள்
Eustachian tube	-	යුස්ටේකීය නාළය	-	ஊத்தேக்கியாவின் குழாய்
Auditory nerve	-	ශ්‍රවණ ස්නායුව	-	செவிநரம்பு
Semi-circular canals	-	අර්ධ චක්‍රාකාර නාළ	-	அரை வட்டக்கால்வாய்