Chapter 11: The Human Eye & the colourful world

P11

1. **What is retina?**

   The light sensitive screen in the human eye is called retina.

2. **Write the function of retina in human eye.**

   Retina acts as a light sensitive screen where the image of the object is formed.

3. **What is cornea?**

   Cornea is a thin transparent bulged portion of the human eye.

4. **What is iris?**

   Iris is a dark muscular diaphragm that controls the size of the pupil.

5. **What is function of pupil?**

   Pupil regulates and controls the amount of light entering the eye.

6. **How do we see erect image of an object?**

   The eye lens forms an inverted real image of the object on the retina. The light-sensitive cells in the retina get activated upon illumination and generate electrical signals. These signals are sent to the brain via the optic nerves. The brain interprets these signals, and finally, processes the information so that we see an erect image of the objects.

7. **What happens when the cornea, pupil, eye lens, aqueous humour and vitreous humour is damaged?**

   If any of the structures involved in the transmission of light, like the cornea, pupil, eye lens, aqueous humour and vitreous humour or those responsible for conversion of light to electrical impulse, like the retina or even the optic nerve that transmits these impulses to the brain, is damaged, it will result in visual impairment.

8. **Why are we not able to see objects clearly for some time when we enter from bright light?**

   When the light is very bright, the iris contracts the pupil to allow less light to enter the eye. However, in dim light the iris expands the pupil to allow more light to enter the eye. Thus, the pupil opens completely through the relaxation of the iris.

9. **How are we able to see things in a dim-light room?**

   You may be able to see things in the dim-lit room because the pupil of an eye which acts like a variable aperture whose size can be varied with the help of the iris. In dim light the iris expands the pupil to allow more light to enter the eye.

10. List the parts of the human eye which control the amount of light entering into it. Explain how they control.

Iris and pupil together control the amount of light entering into the eye. Iris controls the size of the pupil. When the iris contracts the pupil, a small amount of light enters the eye. When iris expands the pupil, this allows more light to enter the eye.

11. What is crystalline eye lens?

The crystalline eye lens is a fibrous, jelly-like material which is capable of increasing or decreasing the curvature.

12. Mention the role of crystalline lens in the human eye.

The crystalline lens provides the finer adjustment of focal length required to focus objects at different distances on the retina.

13. How we able to see nearby and distant objects?

The curvature of the lens can be modified by the ciliary muscles. When the ciliary muscles are relaxed, the lens becomes thin. Its focal length increases. This enables us to see distant objects clearly. When you are looking at objects closer to the eye, the ciliary muscles contract. This increases the curvature of the eye lens. The eye lens then becomes thicker. The focal length of the eye lens decreases. This enables us to see nearby objects clearly.

14. What is meant by power of accommodation of the eye?

The ability of the eye lens to adjust its focal length is called accommodation.

15. In which of the following cases the focal length of the eye lens will be more?
a) When ciliary muscles of a normal eye is most relaxed.

b) When ciliary muscles of a normal eye is most contracted state.

Focal length of the eye lens will be more when more when ciliary muscles are in most relaxed state. It is because in this state, eye lens becomes thinner, hence the focal length increases.

16. What is meant by least distance of distinct vision or near point of the eye?

The minimum distance, at which objects can be seen most distinctly without strain, is called the least distance of distinct vision or near point of the eye.

17. What is the value of least distinct of distinct vision or near point of the eye?

For a young adult with normal vision, the near point is about 25 cm.

18. What is far point of the eye?

The farthest point upto which the eye can see objects clearly is called the far point of the eye. It is infinity for a normal eye.

19. Draw a neat diagram of the structure of the human eye.

20. What is cataract?

The crystalline lens of people at old age becomes milky and cloudy. This condition is called cataract.

21. Name the eye defect in which eye lens becomes cloudy or milky. Write the method for its correction.

The defect of the eye is cataract. It can be corrected through cataract surgery.

22. What are the advantages of having two eyes for vision?

a) Two eyes gives a wider field of view.

b) The ability to detect faint objects is enhanced with two detectors instead of one.

c) Two eyes give the third dimension of depth.

23. Mention the three main defects of vision.

Three common refractive defects of vision. (i) Myopia or near-sightedness, (ii) Hypermetropia or far - sightedness, and (iii) Presbyopia.

24. What is myopia or near-sightedness?

Myopia is a common defect of the eye in which a person is able to see nearby objects clearly but cannot see distant objects distinctly. The image is formed in front of the retina and not on the retina.

25. What is the cause of myopia?

Myopia may be caused due to:

(i) Excessive curvature of the eye lens.

(ii) Elongation of the eyeball.

26. How can myopia be corrected?

Myopia can be corrected by using a concave lens of suitable power.

27. A person is not able to see distinctly the objects placed beyond 90cm from him. Give reason to identify the defect in his eye. Determine the nature of lens used to correct the defect.

The defect is because the image of a distant object is formed in front of the retina and not on the retina. The defect is myopia or shortsightedness. Concave lens is used to bring the image back on the retina.

28. What is hypermetropia or far-sightedness?

Hypermetropia or far-sightedness is a common defect of the eye in which a person is able to see distant objects clearly but cannot see near-by objects distinctly. The light rays from the near-by objects are focused at a point behind the retina.

29. What are the causes for hypermetropia?

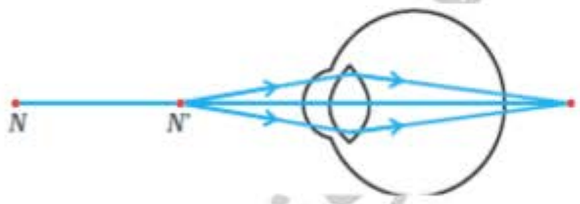
Hypermetropia is caused either because
(i) the focal length of the eye lens is too long,
(ii) the eyeball has become too small.

30. How can hypermetropia be cured?

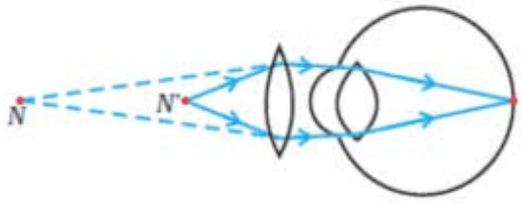
Hypermetropia can be corrected by using convex lens of appropriate power.

31. A person can see distant sign boards clearly but cannot read clearly a book which is at 25cm from his eye. Give reason to identify the defect. Draw diagram to illustrate this defect and correction.

The person is suffering from hypermetropia because the person is only able to see objects far away from the eyes. Convex lens of suitable focal length is required to correct the defect.



Defect



Correction

32. The near point of a hypermetropic eye is 75cm. Calculate the focal length and power of the lens used in his spectacles.

u = - 25cm (Least distance of distinct vision)

v = - 75cm

$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$$

$$\frac{1}{f}=\frac{-1}{75}-\left(\frac{-1}{25}\right)=\frac{-1}{75}+\frac{1}{25}=\frac{-1+3}{75}=\frac{2}{75}$$

$$f=37.5\text{cm}$$

$$P=\frac{1}{f}=\frac{1}{37.5\text{cm}}=\frac{1}{0.375\text{m}}=2.66\text{D}$$

33. What is presbyopia?

Presbyopia is a common defect of the eye in which a person finds it difficult to see nearby objects comfortably and distinctly without corrective eye-glasses. It is caused when the power of accommodation of the eye decreases with ageing.

34. What is the cause of presbyopia?

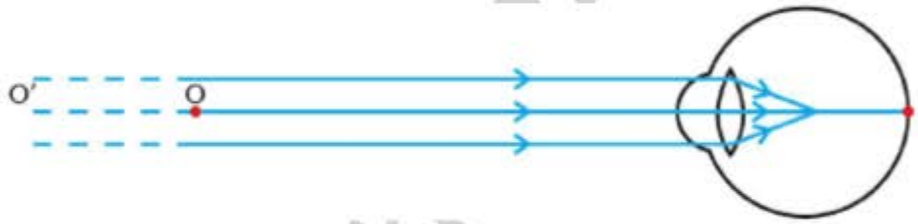
Presbyopia arises due to the gradual weakening of ciliary muscles and diminishing flexibility of the eye lens.

35. A person is found using bi-focal lens. What defect of the eye is the person suffering from?

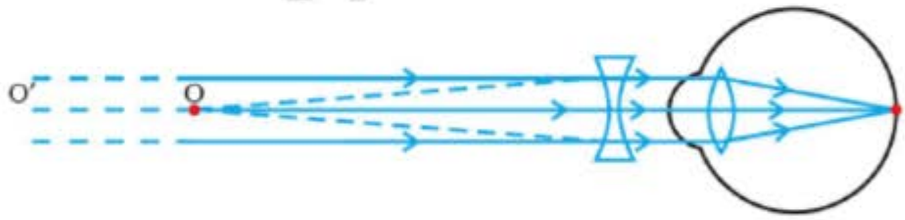
A person may suffer from both myopia and hypermetropia. Such people often require bifocal lenses. A common type of bi-focal lenses consists of both concave and convex lenses.

36. A person with a myopic eye cannot see objects beyond 1.2 m distinctly. What should be the type of the corrective lens used to restore proper vision?

The person is able to see nearby objects clearly, but he is unable to see objects beyond 1.2 m. This happens because the image of an object beyond 1.2 m is formed in front of the retina and not at the retina, as shown in the given figure.



To correct this defect of vision, he must use a concave lens. The concave lens will bring the image back to the retina as shown in the given figure.



37. What is the far point and near point of the human eye with normal vision?

The near point of the eye is the minimum distance of the object from the eye, which can be seen distinctly without strain. For a normal human eye, this distance is 25 cm.

The far point of the eye is the maximum distance to which the eye can see the objects clearly. The far point of the normal human eye is infinity.

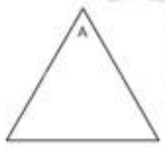
38. A student has difficulty reading the blackboard while sitting in the last row. What could be the defect the child is suffering from? How can it be corrected?

A student has difficulty in reading the blackboard while sitting in the last row. It shows that he is unable to see distant objects clearly. He is suffering from myopia. This defect can be corrected by using a concave lens.

39. What is a prism?

A triangular prism is a transparent material which has two triangular bases and three rectangular lateral surfaces. It is a device used in the laboratory to show splitting of white light into seven colours.

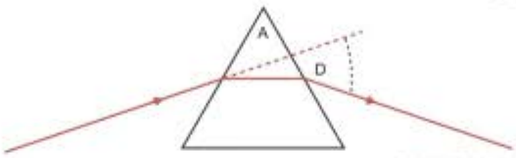
40. What is meant by angle of prism?



The angle between the two lateral faces of a prism is called the angle of the prism.

41. What is meant by angle of deviation?

The angle between the incident ray and the emergent ray is called angle of deviation of the prism.



42. Draw a neat diagram to show the refraction of a light ray through a glass prism and label on it the angle of incidence and angle of deviation.

43. (Activity 11.2) Take a thick sheet of cardboard and make a small hole or narrow slit in its middle. Allow sunlight to fall on the narrow slit. This gives a narrow beam of white light. Now, take a glass prism and allow the light from the slit to fall on one of its faces. Turn the prism slowly until the light that comes out of it appears on a nearby screen.

What do you observe? You will find a beautiful band of colours. Why does this happen?

The glass prism splits the incident light white light into a band of colours. Different colours of light bend through different angles with respect to the incident ray as they pass through the prism.

44. What is a spectrum?

The band of the coloured components of a light beam is called spectrum.

45. What is dispersion?

The splitting of white light into its component colours is called dispersion.

46. What is the cause of dispersion?

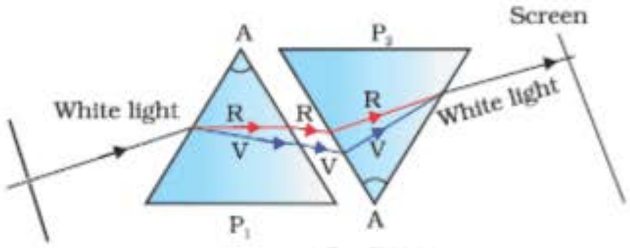
Different colours of light bend through different angles with respect to the incident ray, as they pass through a prism.

47. Which ray bends the most and least when white light passes through a prism?

The red light bends the least while the violet the most.

48. Explain how the components of white light can be recombined after a prism has separated them. Explain with the help of figure.

The first prism P1 splits the white light into seven colours and the second prism in inverted position, again recombines all colours to produce white light. It happens because dispersion produced by the first prism is reversed by the second prism.



49. How is a rainbow formed?

A rainbow is a natural spectrum appearing in the sky after a rain shower. It is caused by dispersion of sunlight by tiny water droplets, present in the atmosphere. A rainbow is always formed in a direction opposite to that of the Sun. The water droplets act like small prisms. They refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop

50. Name the phenomenon responsible for formation of rainbow.

Rainbow is caused due to dispersion of light and internal reflection.

51. No rainbow could be observed from the space by the astronauts. Why?

Rainbow is formed only when the atmosphere contains large number of tiny water droplets in air. As space does not have atmosphere or water, no rainbow is formed.

52. How is the flickering of the objects take place when seen through fire?

Random wavering or flickering of objects seen through a turbulent stream of hot air rising above a fire or a radiator takes place because the air just above the fire becomes hotter than the air further up. The hotter air is lighter (less dense) than the cooler air above it, and has a refractive index slightly less than that of the cooler air. Since the physical conditions of the refracting medium (air) are not stationary, the apparent position of the object, as seen through the hot air, fluctuates.

53. Why do stars appear to twinkle?

The twinkling of a star is due to atmospheric refraction of starlight. The starlight, on entering the earth's atmosphere, undergoes refraction continuously before it reaches the earth. The atmospheric refraction occurs in a medium of gradually changing refractive index. Since the atmosphere bends starlight towards the normal, the apparent position of the star is slightly different from its actual position. The star appears slightly higher

(above) than its actual position when viewed near the horizon. This apparent position of the star is not stationary, but keeps on changing slightly, since the physical conditions of the earth's atmosphere are not stationary.

54. Stars seem higher than they actually are. Explain why.

Light from a star first travels through vacuum and then enters earth's atmosphere. As optical density of air increases towards the surface of the earth, light from the star travels from rarer to denser layers, bending every time towards the normal. On producing the final refracted ray backwards it is seen that the apparent position of the star is higher.

55. Why do planets not twinkle?

The planets are much closer to the earth, and are thus seen as extended sources. If we consider a planet as a collection of a large number of point-sized sources of light, the total variation in the amount of light entering our eye from all the individual point-sized sources will average out to zero, thereby nullifying the twinkling effect.

56. What is the cause of early sunrise and delayed sunset?

The Sun is visible to us about 2 minutes before the actual sunrise, and about 2 minutes after the actual sunset because of atmospheric refraction.

57. What is the cause of flattening of sun's disc?

The apparent flattening of the Sun's disc at sunrise and sunset is also due atmospheric refraction.

58. Why is the colour of the clear sky blue?

The molecules of air and other fine particles in the atmosphere have size smaller than the wavelength of visible light. When sunlight passes through the atmosphere, the fine particles in air scatter the blue colour (shorter wavelengths) more strongly than red. The scattered blue light enters our eyes.

59. What is Tyndall effect?

The phenomenon of scattering of light by the colloidal particles is called Tyndall effect.

60. On what factor does the colour of the scattered light depend?

The colour of the scattered light depends on the size of the scattering particles.

61. Give examples to show how the colour of the scattered particles depend of the size of the particles.

The colour of the scattered light depends on the size of the scattering particles. Very fine particles scatter mainly blue light while particles of larger size scatter light of longer wavelengths. If the size of the scattering particles is large enough, then, the scattered light may even appear white.

62. Which colour is more effective in scattering of light? Why?

Scattering light of shorter wavelengths at the blue end is more effective than light of longer wavelengths at the red end. The red light has a wavelength about 1.8 times greater than blue light.

63. What colour would the sky appear if earth had no atmosphere?

If the earth had no atmosphere, there would not have been any scattering. The sky would have looked dark. The sky appears dark to passengers flying at very high altitudes, as scattering is not prominent at such heights.

64. Why are stop light and danger signals in red colour?

The red is least scattered by fog or smoke. It can be seen in the same colour at a distance. Hence stop signal and danger signals are red in colour.

65. (Activity 11.3) Place a strong source (S) of white light at the focus of a converging lens (L1). This lens provides a parallel beam of light. Allow the light beam to pass through a transparent glass tank (T) containing clear water. Allow the beam of light to pass through a circular hole (c) made in a cardboard. Obtain a sharp image of the circular hole on a screen (MN) using a second converging lens (L2). Dissolve about 200 g of sodium thiosulphate (hypo) in about 2 L of clean water taken in the tank. Add about 1 to 2 mL of concentrated sulphuric acid to the water. What do you observe?

In about 2 to 3 minute, fine microscopic particles begin to precipitate. As the sulphur particles begin to form, you can observe the blue light from the three sides of the glass tank. This is due to scattering of short wavelengths by minute colloidal sulphur particles. The colour of the transmitted light from the fourth side of the glass tank facing the circular hole is at first orange red colour and then bright crimson red colour on the screen.

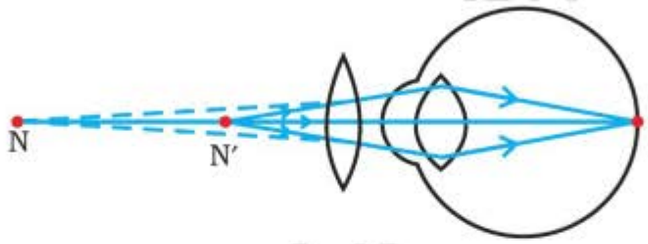
66. Explain why the sun appears reddish at sunrise and sunset.

Light from the Sun near the horizon passes through thicker layers of air and larger distance in the earth's atmosphere before reaching our eyes. Near the horizon, most of the blue light and shorter wavelengths are scattered away by the particles. Therefore, the light that reaches our eyes is of longer wavelengths. This gives rise to the reddish appearance of the Sun.

67. A person needs a lens of power –5.5 dioptres for correcting his distant vision. For correcting his near vision he needs a lens of power +1.5 dioptre. What is the focal length of the lens required for correcting (i) distant vision, and (ii) near vision?

68. The far point of a myopic person is 80 cm in front of the eye. What is the nature and power of the lens required to correct the problem?

69. Make a diagram to show how hypermetropia is corrected. The near point of a hypermetropic eye is 1 m. What is the power of the lens required to correct this defect? Assume that the near point of the normal eye is 25 cm.



The convex lens actually creates a virtual image of a nearby object (N' in the figure) at the near point of vision (N) of the person suffering from hypermetropia. The given person will be able to clearly see the object kept at 25 cm (near point of the normal eye), if the image of the object is formed at his near point, which is given as 1 m.

70. Why is a normal eye not able to see clearly the objects placed closer than 25 cm?

A normal eye is unable to clearly see the objects placed closer than 25 cm because the ciliary muscles of eyes are unable to contract beyond a certain limit. If the object is placed at a distance less than 25 cm from the eye, then the object appears blurred and produces strain in the eyes.

71. What happens to the image distance in the eye when we increase the distance of an object from the eye?

Since the size of eyes cannot increase or decrease, the image distance remains constant. When we increase the distance of an object from the eye, the image distance in the eye does not change. The increase in the object distance is compensated by the change in the focal length of the eye lens. The focal length of the eyes changes in such a way that the image is always formed at the retina of the eye.

72. Why do stars twinkle?

Stars appear to twinkle due to the atmospheric refraction of light. Stars are very far away from the earth. They are considered as point sources of light. When the light coming from stars enters the earth's atmosphere, it gets refracted at different levels because of the variation in the air density at different levels of the atmosphere. When the star light refracted by the atmosphere comes more towards us, it appears brighter than when it comes less towards us. It appears as if the stars are twinkling at night.

73. Explain why the planets do not twinkle?

Planets do not twinkle because they appear larger in size than the stars as they are relatively closer to earth. Planets can be considered as a collection of a large number of point-size sources of light. The different parts of these planets produce either brighter or dimmer effect in such a way that the average of brighter and dimmer effect is zero. Hence, the twinkling effects of the planets are nullified and they do not twinkle.

74. Why does the Sun appear reddish early in the morning?

During sunrise, the light rays coming from the Sun have to travel a greater distance in the earth's atmosphere before reaching our eyes. In this journey, the shorter wavelengths of lights are scattered out and only longer wavelengths are able to reach our eyes. Since blue colour has a shorter wavelength and red colour has a longer wavelength, the red colour is able to reach our eyes after the atmospheric scattering of light. Therefore, the Sun appears reddish early in the morning.

75. Why does the sky appear dark instead of blue to an astronaut?

The sky appears dark instead of blue to an astronaut because there is no atmosphere in the outer space that can scatter the sunlight. As the sunlight is not scattered, no scattered light reach the eyes of the astronauts and the sky appears black to them.

76. Mention any two phenomenon which occur due to scattering of light.

a) Tyndall effect.

b) During sunrise and sunset, sky appears red.

Multiple choice questions

1. The human eye can focus objects at different distances by adjusting the focal length of the eye lens. This is due to

(a) presbyopia. **(b) accommodation.** (c) near-sightedness. (d) far-sightedness.

2. The human eye forms the image of an object at its

(a) cornea. (b) iris. (c) pupil. **(d) retina.**

3. The least distance of distinct vision for a young adult with normal vision is about

(a) 25 m. (b) 2.5 cm. **(c) 25 cm.** (d) 2.5 m.

4. The change in focal length of an eye lens is caused by the action of the

(a) pupil. (b) retina. **(c) ciliary muscles.** (d) iris.

5. A person cannot see distinctly objects kept beyond 2 m. This defect can be corrected by using a lens of power

(a) + 0.5 D **(b) – 0.5 D** (c) + 0.2 D (d) – 0.2 D

6. A student sitting on the last bench can read the letters written on the blackboard but is not able to read the letters written in his text book. Which of the following statements is correct?

(a) The near point of his eyes has receded away

(b) The near point of his eyes has come closer to him

(c) The far point of his eyes has come closer to him

(d) The far point of his eyes has receded away

7. A prism ABC (with BC as base) is placed in different orientations. A narrow beam of white light is incident on the prism as shown in Figure 11.1. In which of the following cases, after dispersion, the third colour from the top corresponds to the colour of the sky?

(a) (i) **(b) (ii)** (c) (iii) (d) (iv)

8. At noon the sun appears white as

(a) light is least scattered

(b) all the colours of the white light are scattered away

(c) blue colour is scattered the most

(d) red colour is scattered the most

9. Which of the following phenomena of light are involved in the formation of a rainbow?

(a) Reflection, refraction and dispersion

(b) Refraction, dispersion and total internal reflection

(c) Refraction, dispersion and internal reflection

(d) Dispersion, scattering and total internal reflection

10. Twinkling of stars is due to atmospheric

(a) dispersion of light by water droplets

(b) refraction of light by different layers of varying refractive indices

(c) scattering of light by dust particles

(d) internal reflection of light by clouds

11. The clear sky appears blue because

(a) blue light gets absorbed in the atmosphere

(b) ultraviolet radiations are absorbed in the atmosphere

(c) violet and blue lights get scattered more than lights of all other colours by the atmosphere

(d) light of all other colours is scattered more than the violet and blue colour lights by the atmosphere

12. Which of the following statements is correct regarding the propagation of light of different colours of white light in air?

(a) Red light moves fastest

(b) Blue light moves faster than green light

(c) All the colours of the white light move with the same speed

(d) Yellow light moves with the mean speed as that of the red and the violet light

13. The danger signals installed at the top of tall buildings are red in colour. These can be easily seen from a distance because among all other colours, the red light

(a) is scattered the most by smoke or fog **(b) is scattered the least by smoke or fog**

(c) is absorbed the most by smoke or fog (d) moves fastest in air

14. Which of the following phenomena contributes significantly to the reddish appearance of the sun at sunrise or sunset?

(a) Dispersion of light **(b) Scattering of light**

(c) Total internal reflection of light (d) Reflection of light from the earth

15. The bluish colour of water in deep sea is due to

(a) the presence of algae and other plants found in water

(b) reflection of sky in water

(c) scattering of light

(d) absorption of light by the sea

16. When light rays enter the eye, most of the refraction occurs at the

(a) crystalline lens **(b) outer surface of the cornea**

(c) iris (d) pupil

17. The focal length of the eye lens increases when eye muscles

(a) are relaxed and lens becomes thinner

(b) contract and lens becomes thicker

(c) are relaxed and lens becomes thicker

(d) contract and lens becomes thinner

18. Which of the following statement is correct?

(a) A person with myopia can see distant objects clearly

(b) A person with hypermetropia can see nearby objects clearly

(c) A person with myopia can see nearby objects clearly

(d) A person with hypermetropia cannot see distant objects clearly

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